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THE
LARYNGOSCOPE.

VOL. LXVI SEPTEMBER, 1956 No. 9

RHINOLOGY IN CHILDREN

Resume of and Comments on the Literature for 1955

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In this resume of the literature pertaining to rhinology in children the usual journals have been covered. The articles abstracted have been roughly classified under the headings previously used, and follow the same order.

GENERAL ARTICLES ON RHINOLOGY

The treatment of the common cold in infants and children consists mainly in the relief of symptoms as they arise, says a writer in *Jour. A. M. A.*[1] Treatment should not be standardized, but should be suited to the needs of each patient. The essential requirements of the patient are rest, ample moisture and warmth. Rest in bed, especially if fever is present, diminishes the severity of the common cold, limits its spread to others, and reduces the frequency of complications. This has stood the rigid test of time as a most sane and effective measure.

Although salicylates and other fever reducing medicaments have no effect on the infectious process, they do control headache and muscular aches; however, these should not

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be given routinely but only when necessary. Sulfonamide compounds, penicillin, and other antibiotics are ineffective in virus initiated colds, but are valuable in the treatment of complications of the common cold. It would not be advisable to prescribe these therapeutic agents routinely for the prevention of bacterial complications, especially since it is difficult to prognosticate the course pursued by the common cold in any given patient. Temporary relief from the discomfiture of nasal obstruction justifies the use of nasal medication on a rational physiological basis.

Since the common cold in infancy often tends to produce complications, it requires adequate attention. A soft rubber ear syringe may be used to clear the nasal passages of infants who have considerable nasal drainage. The bulb of the syringe is compressed before introduction into the nostril and then allowed to expand, a procedure that withdraws the offending nasal discharge. When the opposite nostril is allowed to remain open there is no danger from excessive negative pressure. When the infant cannot take the breast or bottle because of breathing difficulty, due to suppurative nasal blockage, the use of the syringe immediately before feeding time frequently enables the child to take nourishment.

Sanders[2] considers the child with persistent nasal symptoms as a very common but frequently unsatisfactory problem. It is usual for such a child to remain without accurate diagnosis; for there are many doctors who cannot make a nasal examintion, and there are also many otolaryngoloists who have neither the time nor the patience necessary to examine and treat children. All children with nasal symptoms should have a nose and throat examinaton that is thorough. Differentiating allergy from infection in all cases is necessary. A thorough nasal examination should be performed before removal of tonsils and adenoids. Removal of tonsils and adenoids should not be expected to clear up nasal symptoms in all patients.

Walsh[3] discussed vasomotor rhinitis. Allergic rhinitis by common usage refers to cases such as hay fever where the symptoms are acute, due to an antigen-antibody reaction which can usually be demonstrated by history or by skin tests. The

problem of vasomotor rhinitis is more difficult, because it is rare to find a causative allergen. An exception where the patient is likely truly allergic is the spoiled child, who, though he "picks at his meals" is well nourished. Careful inquiry shows that the child consumes excessive candy and pop between meals. The resultant vasomotor rhinitis can be cured by proper regulation of diet.

Endocrine dysfunction may also cause nasal congestion. Not only thyroid but ovarian and testicular hormones as well.

Emotions also effect peripheral vascular mechanisms and lead to upset nasal function which can lead to chronic organic changes in the nasal mucosa and can even cause eosinophilia. It is not clear whether these endocrine and psychosomatic effects occur only in allergic individuals.

With respect to management, nasal sprays and vasoconstrictors are to be avoided, but vasoconstrictors by mouth plus antihistamines are helpful.

If thyroid is indicated, increase the dosage until mucosal changes are evident. Then gradually reduce to a maintenance dose.

The addition of thiamine and ascorbic acid may also be advisable.

Volume 48[4] of the Proceedings of the Royal Society of Medicine presented a discussion on the relations of nasal disease to asthma.

Brockbank[4] has been impressed by the large number of asthmatic cases that have nasal trouble as well. In 221 cases only 27 per cent denied nasal trouble; but in this series, although 24 patients had antral lavage, only in eight of the patients was there purulent material in the returns. That is, in the series of 221 cases only eight patients had true sinus infection.

The infective asthmatics whose attacks are always associated with fever, and in whom the offending organism has been lying dormant in the sinuses, are as a group benefited by antrum wash-outs.

Other nasal operations have not been helpful in relieving asthmatic spasm. Often the reverse is true. Many patients date the onset of their first bout of asthma from the removal of nasal polypi, or the correcting of a deflected septum.

Maunsell[4] believed that food allergens were more important in childhood, and in particular aspirin should be viewed with suspicion. Aspirin may cause violent asthma and 5 grains may be fatal.

Hogg[4] agreed that as a general rule the nasal manifestations were part of the allergic diathesis, but that there remained a small important group of patients in whom the asthma seems to depend upon the existence of infection in the nose and sinuses.

Polypi do not cause asthma, but if they are causing nasal obstruction and interfering with sinus drainage they may well aggravate the sinus attacks. The same may be said for correction of septal deformities. This should be done only if imperative for the treatment of diseased nasal sinuses.

Lambert[4] on the other hand said that he taught his students that no asthmatic should be allowed to suffer from any form of nasal obstruction which could be corrected. He thought that the reflex of Dixon and Brodie, where bronchial spasm was produced in animals by stimulating the nasal septum, was a real entity. Sometimes in reflex nasal asthma the attack can be broken by cocainizing the spheno palatine foramen.

Reeves[4] stressed the importance of training children to blow their noses. With ability to do this often a child will achieve, a clean efficient airway. He feels that adenoidectomy for nasal obstruction in a child with a family history of hay fever or asthma should be done with a guarded prognosis.

Two consultants[5] asked the *Jour. A. M. A.* for suggestions regarding diagnosis and treatment of a two-and-a-half year old child who had infrequent attacks of asthma but a constant eosinophilia ranging from 23 per cent to 38 per cent of the total white blood cell counts. Each mentioned many conditions which should be looked for, both emphasizing the search for parasites.

Greenstein[6] writes to the *Jour. A. M. A.* that a new nasal decongestant introduced under the name of Tyzine should be used with caution because of soporific side effects. He describes how infants treated with it could not be roused until the sedative wore off, and he describes one alarming experience with a seven-month-old infant.

The caution is supported by Friedman, of Los Angeles, who describes an alarming reaction in his own 22-month-old daughter. He warns against the use of such medicaments in the plastic spray bottles. He states that there are two lessons that the medical profession should be immediately informed about from his experience. Some agents for local applications to the nasal membrane can cause severe reactions in children with inflamed membranes, and spray medicaments should not be used in children, as the dosage given cannot be judged and may be far greater than the average amount given by dropper.

Parish[7] makes several pertinent comments on the above letters. He points out that one letter clearly emphasized that overdosage in treating infants with any nasal decongestant must be avoided. He shows that the manufacturers of Tyzine indicated the possibility of soporific effects in infants and printed instructions that both the patient and the bottle must be upright for the administration, in order to avoid pouring the solution as a stream. His own extensive experience showed that no unfavorable effects had occurred when these precautions were followed.

Comment. It is difficult for a mother to carry out such instructions. It is practical, usual and easier to put drops in the infant's nose when it is lying on its back. Unless the dangers are printed in big print on the container, the mother will not read the manufacturer's caution. We, therefore, commend the remarks made by Greenstein and Friedman.

Tompkins and Macaulay[8], noting that the multinucleate giant cell of lymphoid tissue know as the Warthin-Finkeldey cell is a well-known finding in prodromal measles, considered that these cells might occur in nasal mucus. They demonstrated these cells in ten patients ranging from five days prodromal to the day of exanthem. Control preparations

from patients with upper respiratory tract infections, allergic states, rashes, roseola, and rubella failed to show any comparable structures.

They describe the technique clearly.

Their own experience has been so encouraging that they recommend the method to their clinical and laboratory colleagues and are gratified to discover that the disease may be so simply and directly identified in the laboratory.

Schenck[9] stressed the importance of the plasma cell theory of antibody formation in the interpretation of the physiology of the lymphoid structures of Waldeyer's ring. The theory is that an unaltered bacterial cell is split by reticuloendothelial cells and polymorphonuclear leukocytes into chemically active antigenic molecules. These are then able to stimulate the plasma cells in the synthesis of gamma globulin containing the majority of humoral antibodies. These activities take place in lymphoid tissue.

The strategic position of the lymphoid tissues of Waldeyer's ring suggests that they initiate reactions to produce antibodies against organisms present in the upper respiratory tract and oral cavity.

The physiological variations in size of Waldeyer's ring appear to conform with immunologic requirements, further lending weight to the theory that the prime function of Waldeyer's ring is the formation of antibodies.

NASOPHARYNX.

Ireland[10], writing of pathological lesions in the nasopharynx, states that the patient may present himself with the following symptoms. *1.* Obstruction to nasal breathing. *2.* Postnasal discharge, purulent, mucoid or bloodstained. *3.* Unilateral or bilateral deafness. *4.* Involvement of various cranial nerves. *5.* Unexplained firm mass in the cervical lymph nodes. He discusses the pathological causes of each of these and briefly outlines the treatment.

The discussion is general in scope but has some particular application to the problems of children. Under nasal obstruc-

tion he mentions naso-antral polyp, inperforate choanae, adenoids and benign naso-fibroma. He states that he does not cover the subject completely or discuss all the various treatments. His purpose is to correlate specific pathological lesions in the nasopharynx with the associated clinical symptoms.

This comprehensive pathological review should be read in its entirety.

Fenton[11] presented conclusions up to the present on nasopharyngeal defense mechanisms.

The first line of defense is the epithelium which is by its ciliary activity and its covering of mucous secretion removes inert dust and bacteria. The pH of the nasal secretion is changed with the onset of local disease, and there is an increase in the mucous secretion to cope with the irritant. This is to strengthen this first line of defense, but it may produce detrimental blockade of the nasal passages and filling of the sinuses.

The efficiency of the epithelial defense mechanism is altered by allergies, hyperventilation or loss of cilia due to trauma.

Infection of sinus mucosa changes it from simple thin ciliated columnar epithelium to a thick membrane with much edema and infiltration of phagocytic cells.

These cells constitute the second line of defense, but the swelling may increase and aggravate the situation by closing the sinus ostia. When this state of affairs has existed for a month or so the actively phagocytic neutrophiles and histiocytes are replaced by plasma cells and fibrocytes which work together to encourage healing.

The retropharyngeal and superior cervical lymph nodes are the third line of defense.

When the infection passes these barriers drainage into the cervical lymph ducts may occur with eventual drainage into the superior vena cava. This in turn can carry the infection via the right heart and pulmonary capillary bed to the perivascular and peribronchial lymphatics, which are

the fourth barrier to systemic invasion by upper respiratory infection.

SINUSITIS.

A paper on sinusitis in children was presented by Wishart and Wallace[12] before the Canadian Otolaryngological Society. They did not pretend to give a complete treatise on sinustis in children, but instead they discussed the present attitude at the Hospital for Sick Children in Toronto towards sinusitis in these patients. Sinusitis is the common cold which has invaded a sinus; in children it is exceedingly common, the antrum being the sinus most frequently involved.

In the milder types the sinus is unable to perform its normal function, because an obstruction near the ostium so impairs the activity of the cilia of the lining membrane that they cannot evacuate the infection. When the trouble is more severe or of longer duration there is a puddle of discharge which is too heavy for the cilia to remove. If function can be restored in these cases, a cure results.

The nasal mucosa of a child with acute sinusitis rarely shows marked injection. Good inspection of the membrane is obtained by nasal shrinkage after a preliminary spraying with a mild vaso-constrictor. The use of the nasopharyngoscope is important and gives one an accurate picture of the nasopharynx and adenoid pad if present. X-rays of the sinuses are a help but should not be taken during an acute upper respiratory infection.

A great preventive of sinusitis is the natural cleansing of the nose. Many babies cannot get rid of the nasal secretions on their own, but placing the infant face down allows the secretions by gravity to fall to the front of the nose where the crying child will snort them out. Natural evacuation of the sinuses can be helped by treatment with vaso-constrictor drops. These drops must reach the middle meatus, and to do this the lateral-head-low position described by Parkinson is used.

Antrum lavage is a valuable procedure, and many antra that have been cloudy on X-ray over a long period will clear

on one antrum washing; others require several washings to clear, and if the measure has failed then antrostomy is necessary. In performing an antrostomy a blunt Kerrison punch is used to bite out an opening, and great care is taken not to damage the inferior turbinate.

Acute ethmoiditis in a child is characterized by swollen, discolored eyelids and is often mistaken for an ophthalmic condition. The source of the infection is the anterior ethmoid cells, and unless this area is treated adequately, recurrences will happen.

The milder type of sinusitis is relatively free of exudate at times, especially in the summer months. Small doses of triple sulphonamides daily all winter help these children greatly by keeping them free from secondary infection. The more severe types are never free of exudate, and some of these patients require repeated lavage, or intranasal antrostomy, or sometimes the Caldwell-Luc operation.

The nose is an important physiological organ, and treatment of it should be governed by good medical principles. Surgical technique employed in the treatment is very important, but it should be subservient to good medical evaluation.

Brown[13] says that in his experience the commonest cause of abdominal pain in children is chronic sinusitis. Evidence of chronic sinusitis as a frequent cause of abdominal pain is discussed under the headings of seasonal variance, presence of colds and other symptoms of sinusitis, diseases associated with both abdominal pain and sinusitis, and response to treatment of sinusitis.

Seasonal Variance. Comparatively few cases of abdominal pain are encountered in hot summer weather. In the fall, abdominal pain becomes a prominent symptom, and is also frequent in winter and spring.

Presence of Colds and Other Symptoms of Sinusitis. The author claims he has found usually sinusitis present in children with recurring abdominal pain, and children with sinusitis often complain of abdominal pain. The most common

symptoms observed were anorexia, nausea, vomiting, head cold, cough, low-grade fever, fetor oris, photophobia, headaches and pain in the legs. Although other causes will produce each symptom, only sinusitis produces all of them. Signs of sinusitis in children with abdominal pain include circles and puffy under eyes, puffs beside nose, nasal obstruction, mouth-breathing, photophobia, sinus tenderness and cervical adenitis despite a previous tonsillectomy. The cervical adenitis is secondary to bacterial toxins from a sinusitis and the mesenteric adenitis may have a similar origin.

Diseases Associated with Both Abdominal Pain and Sinusitis. Many diseases are discussed which have a common organism producing the abdominal pain and nasopharyngitis or sinustis. Others have simultaneous associated symptoms. These illnesses include mesenteric adenitis, appendicitis, primary peritonitis, rheumatic fever, Henoch's purpera and some cases of so-called colic.

Response to Treatment of Sinusitis. The cause of the abdominal pain must be determined before treatment is commenced. One must rule out surgical and other serious conditions which occur in only 5 per cent of these cases. The large group which is secondary to upper respiratory infections respond well to the treatment of an active sinusitis. The nose is kept free by means of Isotonic astringent nose drops, or sprays followed by hot wet towels to the face after applying cold cream. This treatment is carried out three times daily, or more often if the nose is obstructed. The head-up position is used during sleep and Fowler's sitting-up position during working hours. When abdominal pain is due to acute sinusitis a penicillin injection is added to the above treatment.

To prevent recurrance of abdominal pain in children the treatment of chronic sinusitis twice daily should be carried on indefinitely.

The feature which makes sinusitis in children more important than the foci of infection is the development of pus under tension, which occurs in the confined space of a sinus.

Thompson[14] reported a fatal case of air-embolism following antral lavage.

The patient was a five-year-old boy who had the lavage done under general anesthesia. When the trocar was introduced there was some difficulty, and the operator had the impression that the instrument had gone on through and struck the postero lateral wall. The attempt to lavage with saline produced a very poor trickle. Afterwards air was blown into the antrum in the usual manner. There was some resistence to the flow of air through the antrum. Suddenly it was observed that the child had stopped breathing and was ashen grey. Resuscitation measures including cardiac massage failed to revive the patient, and at autopsy the child was found to have died from air-embolism introduced through a small puncture in the mucosa of the antrum opposite the site of entry.

In 1920 Gording was able to produce convulsions and death in rabbits by the insufflation of air into the maxillary sinus. Pang in 1952 quoted 58 cases with 23 deaths in humans.

Air embolism is a rare complication of injecting air into the antrum, but enough cases have been recorded to make it reasonable to inquire what is gained by this insufflation of air.

Since the fatality here reported the author has discontinued the insufflation of air and has never had cause to regret the decision.

He usually asks the patient to blow his nose gently, and this expels a few drops of the irrigation solution through the cannula. He considers there is no danger of self induced air embolism because there is also increased intra thoracic pressure.

DRUGS

Owings[15] reported on the control of postoperative adenoid bleeding with Adrenosem in the Germantown Hospital. Prior to using this drug their incidence was as high as 10 per cent of all cases.

Since using Adrenosem routinely there was only one case of adenoid bleeding in 102 cases plus three others which showed some bright red blood from the nose and mouth. These three cases were quickly controlled by a 5 mg. intramuscular injection of the drug.

Adrenosem checks bleeding from a capillary bed by correction of excessive permeability. It has no sympathomimetic action and appears to be non-toxic.

It can be given orally or intramuscularly. When given intramuscularly it is given shortly before operation.

Peele[16] reported on the use of Adrenosem in the control of hemorrhage from the nose and throat.

Adrenosem is a synthetic chemical. It is an oxidation product of epinephrine which is prepared as a stable aqueous solution by using sodium salicylate as a solubilizing agent.

Adrenosem has no sympathomimetic action, nor has it any effect on the blood-clotting mechanism. It exerts an increase in capillary resistance and a reduction of excessive permeability. The drug has no effect on large severed blood vessels or arterioles.

Adrenosem has a very high index of therapeutic safety, and there are no contraindications to its use at recommended dosage levels.

There is, however, evidence to show that the effects of Adrenosem are inhibited by the action of antihistamines, and these drugs should be discontinued for 48 hours before the administration of Adrenosem.

CONCLUSIONS.

The data assembled in this study seem to warrant the following preliminary conclusions. The routine preoperative use of Adrenosem in tonsil and adenoid surgery diminishes both the bleeding at the time of operation and the oozing in the immediate postoperative period. As a result of the reduced bleeding at operation fewer patients require suture of the tonsillar fossae for the control of hemorrhage. The inci-

dence of primary postoperative hemorrhage may be reduced. Adrenosem is valuable in the active treatment of postoperative tonsil and adenoid bleeding and may reduce the incidence or obviate the necessity of postnasal packing or sutures.

In case of submucous resection of the nasal septum the use of Adrenosem reduces the bleeding at the time of operation, in the postoperative period, and after removal of the nasal packing.

Preoperative Adrenosem reduces the bleeding following removal of benign inflammatory growths from the subglottic larynx and the operative field is thereby better visualized to determine completeness of removal.

Adrenosem is valuable in the control of hemorrhage from the choanal region of the nose seen in cases of hypertension, arteriosclerosis, or respiratory infections with or without local predisposing pathological conditions in the nasal cavity. The necessity of postnasal packing may be obviated by Adrenosem therapy in the majority of these types of cases.

Menger[17] reported on the use of parenteral estrogen in six cases of spontaneous epistaxis and ten cases of hemorrhage following adenoidectomy:

"The response in all cases was dramatic, and in only three cases was the length of time between the administration of the medicament and the cessation of bleeding over one hour. The consistency and rapidity of response rule out the possibility of automatic cessation and coincidence. Three possible mechanisms of action of estrogen are considered, but besides the passing evidence that estrogen may stimulate the release of thrombocytes, this study does not contribute any information toward the solution of the enigma. Even though the therapy at the present must be considered empirical, the effectiveness of parenterally given estrogen and the control of spontaneous epistaxis and bleeding following adenoidectomy offer strong evidence that merits serious consideration."

Harkins[18] made a study of the effects of vitamins K and C on postoperative bleeding after adenotonsillectomy.

Previous investigators had not been able to show any

benefit as regards to hemorrhage where vitamin K was used alone.

Since vitamin C is of importance to healing and vitamin K is concerned with the prothrombin level a combination of the two vitamins was used in this study.

The study was made on a series of 200 children whose ages ranged from five to 13.

One hundred of the children received vitamin C and vitamin K for five days before operation and for five days after operation.

Fifty of these were allowed acetylsalicylic acid postoperatively and the other 50 were denied salicylates in any form.

The other 100 patients constituted a control group who received no vitamin C or vitamin K, and were allowed acetylsalicylic acid during their convalesence.

The results showed a reduction in the incidence of postoperative bleeding (both primary and delayed) from 14 per cent to 3 per cent. The frequency of postoperative hemorrhage was not increased in patients who were allowed acetylsalicylic acid if they also had been treated with both vitamin C and vitamin K. No toxic symptoms were noted which might be attributable to the vitamins.

Although careful bleeding and clotting time studies were made in all patients, these tests failed to indicate impending bleeding in the children who did suffer postoperative hemorrhages.

ALLERGY.

Van Alyea[19] has discussed the management of allergic sinusitis and stresses the need for close co-operation between the allergist and rhinologist.

He made several interesting observations which are worth noting. Contrary to general belief, polyps do not originate from within ethmoid cells. They commonly arise from the margins of sinus ostia, the crest of the ucinate process and anterior face of the bulla ethmoidalis; therefore it is not

necessary to interfere with the ethmoid cells in the operation of polypectomy.

Allergic sinusitis can be roughly calculated into five groups:

1. Acute suppurative sinusitis on an allergic basis.

2. Subacute sinusitis maintained by structural drainage barriers and allergic edema.

3. Acute and subacute cases with drainage difficulty due to polyps.

4. Chronic sinusitis with blockage of outlets by edema.

5. Chronic sinusitis with or without polyps which has been subject to one or more radical operations.

Treatment in addition to careful allergic management is the same as in non-allergic cases with the goal ever being the establishment of adequate drainage.

Radical procedures are seldom advisable because allergic membranes removed are replaced by membranes also allergic and the patient's symptoms temporarily relieved may return along with others and perhaps be more pronounced than previously.

The *Jour. A. M. A.*[20] was asked if allergy to milk, in addition to bloating, also causes an increased post-nasal discharge. They replied that when a patient attributes mucus to milk, allergy to milk often is responsible, but goes on to show the care which must be taken before deciding that an allergy is due to a food.

Segard, of the Wisconsin Alumni Research Foundation, took exception to the above opinion stating, milk does not cause or give mucus or phlegm as commonly called. The mucus is already there in the oral cavity and the pharynx. Milk and other substances containing buffers neutralize the tenacious mucus. It then loses its tenaciousness and can then be expectorated. Speakers, actors, preachers, and others use milk to clear their throat of mucus. This reaction has nothing to do with disease. This reaction can be secured by the average toothpaste; it has nothing to do with allergy.

Craft[21] discussed the relation of allergy to the tonsils and adenoids. The results of adenotonsillectomy are at times disappointing. This is especially common when the patient suffers from a nasal allergy.

The presence of a nasal allergy must be detected by a careful history and thorough examination. It would seem logical to treat the allergy as well, before deciding that removal of tonsils and adenoids is likely to be helpful.

Another relationship occurs in the allergic individual who has developed a bacterial sensitization to organisms harbored in the tonsils or adenoid. This turn of events can be suspected from the history and bacteriological studies, and can be confirmed by intradermal skin testing of the patient with extract obtained from the infecting organism. The results of removal of tonsils and adenoids in this group along with autogenous vaccine is indicated.

A third observation in allergic patients is an increased tendency for the "growing back" of tonsils and adenoids after removal. These regrowths of lymphoid tissue occur especially in the nasopharynx of allergic patients. When the allergy is adequately treated pre-operatively the incidence of regrowth can be reduced from 27 per cent to 3 per cent.

CONGENITAL ABNORMALITIES.

A very lucid description of the mechanism of asphyxia in bilateral choanal atresia is given by J. V. D. Hough[22]. He demonstrates by means of drawings and X-rays the inspiratory and expiratory efforts of the infant when both posterior nares are obstructed. On inspiration the tongue and soft tissues of the floor of the mouth are sucked up and back to the hard and soft palates, producing a seal which prevents entry of air into the trachea. The epiglottis and soft tissues of the pharynx are sucked together, producing almost a drawstring effect. The expiratory effect can be explained by the ballooning produced by trapped air in the nasopharynx. The expiratory squeeze of the lungs and action of the muscles of respiration produces considerable air pressure on expiration. This builds up rapidly in the pharynx and nasopharynx and

forces the soft palate down and backwards againt the tongue, thus producing a soft tissue seal. The pharynx and nasopharynx become greatly dilated. This seal must be broken if life is to be maintained.

The author maintains that the diagnosis of choanal atresia is easily made once the condition is suspected. The infant has intermittent dyspnea with variable degrees of cyanosis from birth. There is retraction of the suprasternal intercostal and infrasternal areas on inspiration; also, there are prolonged efforts at expiration with excessive use of the secondary muscles of respiration. Attempts to feed the infant increases the dyspnea. The cry has a normal sound, and crying visibly relieves the distress of breathing. Closure of the mouth produces immediate cyanosis. Examination of the nose shows considerable mucus lying in each fossa. It is impossible to insert a catheter or blunt probe through the nose into the nasopharynx. Iodized oil dropped into the nose cannot be traced to the pharynx with a roentgenogram.

The first thing to be done in the way of treatment is to break the seal between the palate and the tongue thus permitting better respiration. This is accomplished by passing a plastic tube through the mouth into the stomach. The tube also allows the feeding of the infant with safety. It may be necessary to tape a second catheter in the mouth so that it rests on the back of the tongue, to further break the seal between the soft palate and tongue.

Surgical correction of the defect may now be carried out, and this should be done as soon as possible. The author enumerates several surgical procedures but discards them all for a simple surgical technique which has given good results. Under endotracheal anesthesia a ball-tipped metal probe is inserted along the floor of the nose, close to the septum, until it rests against the atresia. The depth is measured from the columnella. A guarded trochar is passed into the nose to the measured length, taking care to reach the medial and inferior area of the atresia. This area is then penetrated, and the posterior wall is protected by a small laryngeal mirror in the nasopharynx.

Following the trochar, a slightly curved Van Alyea antrum cannula is pushed through the penetrated area to enlarge it slightly. Further enlargement of the orifice in the atresia is accomplished by infant urethral dilators. The penetration and dilatation procedures are repeated in the opposite nares, and so both are made to communicate with the nasopharynx. Two polyethylene tubes the size equal to 14-E are inserted through the nares into the nasopharynx to the back of the soft palate and are secured anteriorly by a safety pin which is taped to the face. The tubes are left in place for three weeks or longer, and during this time they are kept clean by suction and may be replaced if necessary. Local medications in the nose are avoided, but antibiotics may be given systemically to prevent infection. After removal of the tubes the openings may tend to close. If this is so the proper procedure is simple dilatation, as before, when considered necessary.

This seems to be a very practical, simple, and sensible way to treat bilateral choanal atresia in the newborn.

TONSILS.

Moore[23] made some suggestions with respect to general tonsillectomy. Proper preparation of the child is essential. In this regard there is a very clever record by Mercury Childcraft, called "Peter Ponsil Lost His Tonsil". Measures should also be taken to be sure that the parent can be with the child after the operation, so that he does not have the feeling of being abandoned to strangers.

There has been some dissension regarding preanesthetic sedation for children. Heavy enough sedation to reduce the incidence of crying increases the hazards of the anesthesia. It is probably safe to give atropine to most children.

There is also some dissension about the use of endotrachial anesthesia in children. Many experts feel that it is not necessary and may produce postoperative laryngeal edema.

Peritonsillar injection of normal saline containing 6 minims of 1-1000 adrenalin to the ounce will reduce the amount of bleeding during the operation even in adults. These injec-

tions are contra-indicated in children under two, diabetics, and patients with coronary sclerosis. It is also inadvisable where anesthesia is being produced by cyclopropane.

There seems to be mounting evidence that the incidence of secondary hemorrhage is greater when acetylsalicylic acid is used.

The use of efocaine as a long acting local anesthetic to reduce postoperative pain has been of questionable value, and there are reports that there is considerable danger involved.

There is no clear evidence that Cortisone or ACTH produce more bleeding, but some experiences suggest that it might be wise to withdraw the drug for four or five days before the operation is done.

A short period of pre-operative Cortisone, or Hydrocortisone on the other hand, may help protect a thymicolymphatic child from the hazards of surgical trauma; as well, the intravenous use of Hydrocortisone has been found useful in combating the hypotension of surgical shock.

The *Jour. A. M. A.*,[24] asked regarding the relation of diseased tonsils to tonsillectomy, replied that tonsillectomy was not more frequent in families that are in the higher income bracket and that, since virulent organisms are found in tonsils soon after birth, almost all tonsils should be considered diseased.

The Southeast Metropolitan Regional Hospital Board[25] has approved plans for an inquiry into the value of tonsillectomy. At Farnborough Hospital, Kent, England, and perhaps other hospitals in that area, 1,000 children on the tonsils waiting list will be chosen for the trial: 500 will have their tonsils removed and 500 will not. The health of the two groups in the succeeding year will then be compared.

The *Lancet*[26] comments as follows on a study by McCorkle, Hodges, Badger, Dingle and Jordan, which appeared in the *New England Journal of Medicine*, 1955:

"The indications for tonsillectomy may seem to be based more on intuition than on reason. Evaluation of the results, by different methods of assessment, has already cast serious

doubt on the value of the operation. Among the lexicon-like list of reasons for undertaking it, repeated respiratory infections (and what child does not have them?) has been well to the fore. Now McCorkle, et al., have made a painstaking assessment of the relation of tonsillectomy to the incidence of such infections. The study can be criticized at only one point, the small numbers concerned; but the 230 children studied were observed for up to five years, during which the mothers kept a daily health record, field workers paid a weekly visit, and physicians assessed all illnesses with the help of extensive bacteriological investigations."

The results are presented under two headings: under the first heading "the age-specific rate of infection" of two groups of children, tonsillectomised and not, before the period of observation began, is compared. Under the second heading is shown "the age-adjusted rate of infection" in a group of 26 children who, because they had a higher than expected rate of infection, were operated upon during the period of observation. McCorkle, et al., state: "Comparison of these data requires the use of either age-specific or age-adjusted rates, because the incidence of common respiratory illness changes with age, and post-tonsillectomy experience is heavily weighted with older children." The outcome of this study was that the operation had no effect at all, and the 26 children with a higher than expected rate of infection continued unchanged at the higher rate after the operation.

The great care with which this study was conducted suggests that, though the numbers were small, the results would be the same whatever the total.

Rhoads, et al.,[27] reported on a clinical investigation undertaken to throw light on the question of: *1.* The presence of a transient bacteremia after tonsillectomy that is similar to that observed after tooth extraction and its prevention by preoperative treatment with penicillin and other antibiotics; *2.* The amount of information regarding the bacterial content of the deeper lymphoid tissue of the tonsils given by cultures from the surface of the throat; and *3.* How antibiotic therapy affects the bacterial content of the deeper structures of the tonsil.

Their summary and conclusions are as follows:

Blood cultures taken just after tonsillectomy were positive in 28.3 per cent of a group of 68 patients who received no antibiotic therapy prior to tonsillectomy. The incidence of bacteremia was reduced to 5.9 per cent in a group of 20 subjects who received penicillin in a daily dose of 600,000 to 800,000 units intramuscularly for four to ten days prior to tonsillectomy. The incidence of bacteremia in a group of 29 patients who received 600,000 to 800,000 unit doses (half this dose for children) of procaine penicillin 12 to 18 hours and one hour prior to tonsillectomy, or in a small group (seven) of patients receiving 900,000 to 1,200,000 units orally daily for five to seven days prior to operation, was not reduced below that of the control group. Beta hemolytic streptococci were obtained from blood cultures four times, pneumococci once, alpha hemolytic streptococci (green forming) or Gamma a-hemolytic streptococci 28 times, and a combination of Beta hemolytic streptococci and Gama a-hemolytic streptococci twice. The need for several days preoperative treatment with penicillin to prevent post-tonsillectomy bacteremia is obvious.

In the control series of 68 patients who had no antibiotic treatment immediately preceding tonsillectomy, Beta hemolytic streptococci were present in 57.4 per cent of the cultures of the excised tonsils, although these micro-organisms were found in only 28.26 per cent of throat cultures taken just before the operation. Among patients receiving penicillin in simple doses only the day before and the day of tonsillectomy, 31.03 per cent had Beta hemolytic streptococci in the excised tonsils, although these micro-organisms were not present in the throat cultures taken just before tonsillectomy. Beta hemolytic streptococci were found only once in the cultures from the excised tonsils of persons receiving penicillin intramuscularly each day for four to ten days prior to tonsillectomy. Most of the gram-positive micro-organisms except micrococci and Faffkya tetragenus were greatly reduced in number by penicillin administered intramuscularly, but gram-negative micro-organisms, such as Klebsiella pneumoniae, aerobacter aerogenes, and Escherichia coli, were

found in increased numbers in cultures from the throats and excised tonsils of these subjects.

Ferguson, McGarry, Beckman and Broder[28] report that in a four-year-old girl immediately after dental extraction, tonsillectomy and adenoidectomy, a massive subcutaneous surgical emphysema developed and rapidly extended to produce a pneumomediastinum, pneumoperitoneum and a left tension pneumothorax. Recovery was rapid after establishment of underwater closed catheter drainage of the pneumothorax.

The mechanism of the air entry in surgical emphysema following tonsillectomy has been much discussed in the literature. Some authors favor the tonsillar bed as the site, others favor the intrapleural or extrapleural route, and yet a third school of thought claims that pulmonary interstitial emphysema is the initial lesion, and results from respiratory obstruction.

Macklin in his experiments showed that by over-inflation the alveoli can be made to rupture, resulting in a leak of air into the interstitial tissues of the lung. The air may then travel along the walls of the pulmonary blood vessels in artificial channels which it has dissected for itself to the root of the lung and from there into the mediastinum. This may further spread to give extensive pneumomediastinum and even a pneumothorax.

In this particular case the authors believe that the ragged tonsillar beds permitted air to enter the tissue planes during post-operative swallowing and coughing. Operative hemorrhage no doubt led to more trauma to the tonsillar fossae than usual, and this coupled with a moderate amount of respiratory obstruction resulted in the air extravasation, the air traversed tissue planes in the neck and extended into the mediastinum and retroperitoneal area. Rupture of a mediastinal bleb produced the left tension pneumothorax, and a similar sort of event must have allowed air to enter the retroperitoneal space.

Barton and Roman[29] described an endotracheal technique for adenotonsillectomy. The requirements of ideal tonsillec-

tomy anesthesia are that it be safe, not too unpleasant, and that it allows proper working conditions for the surgeon.

To achieve these ends the authors devised three sizes of endotracheal tongue blade which can be used with the Crowe-Davis or the McIvor mouth gags. The blades are constructed with a conduit through which the endotracheal tube can be threaded. The device allows endotracheal intubation without interfering with the surgical field for any kind of otopharyngeal surgery.

They feel that this apparatus overcomes all the objections raised to the use of Pentothal techniques without intubation. They further feel that the technique of endotracheal anesthesia permits the use of heavy premedication or the preoperative use of rectal Pentothal to minimize the psychological shock of the operation.

Comments: At the Hospital for Sick Children in Toronto, we still think that open ether anesthesia is the safest for tonsillectomy in children. We avoid premedication because it prolongs the return of a vigorous cough reflex which is the child's chief protection against the sometimes serious effects of postoperative aspiration of blood or vomitus.

PREMEDICATION AND GUILLOTINE TONSILLECTOMY.

N. G. P. Butler[30] believes that methylpentynol is a very unsatisfactory sedative for children prior to tonsillectomy. He argues this from his own experience and also from his reading of Dr. C. M. Rendell's article in the *Brit. Med. Jour.* of Dec. 11, 1954.

Only two children out of 56 admitted liking the preparation; the remainder disliked it intensely. He agrees with Dr. Rendell that in about a tenth of the cases the induction was delayed by vomiting the elixir. The ward staffs actively disliked the menthylpentynol on account of the almost universal postoperative restlessness and lack of cooperation that accompanied its use. Whereas the non-drug-sedated child is soon completely "round" after the operation and after suitable explanation and reassurance will lapse into quiet sleep, a child who has had methylpentynol is still confused and in-

capable of appreciating the situation, and thus reacts accordingly.

R. J. James Hodges also writes that the evidence in Dr. Rendell's article does not substantiate her favorable conclusions.

D. B. Halstead writes that any premedication swallowed gives increased gastric motility and increased risk of vomiting and its sequelae; any morphine derivative depresses respiration and makes it difficult to obtain the required depth of anethesia, and most children object more to rectal injections than to a gas tactfully given. All the barbiturates make the children restless and difficult to control postoperatively, unless there is a nurse for each patient. He remains convinced that the best and safest premedication is atropine 0.65 mg (by injection) and nothing else.

Gusterson[31] writes that in his opinion the elixir of "oblivion" as put up by Schering is of very great value for children. He has not met a single incident of vomiting in 500 cases. The oblivion should be given one hour before induction and followed by atropine half an hour later. He is preparing a film which he hopes will be convincing.

Methylpentynol is now being prescribed fairly widely as a hypnotic, and as a means of allaying apprehension, but there are relatively few reports of overdosage. The following case report by I. M. Brown and R. A. Ellis, describes recovery after ingestion of approximately 10 g. of methylpentynol in the form of a proprietary elixir ("oblivion") and this appears to be the largest overdosage followed by recovery.

A woman aged 39, weight 7 st. 8 lb., was admitted to hospital on Oct. 29, 1954, having taken approximately 5 oz. (150 ml.) of a proprietary elixir containing 250 mg. of methylpentynol per drachm (70 mg. per ml.) There was a history of previous mental illness, necessitating admission on a voluntary basis to a mental hospital in July, 1954, for a period of ten days. Since that time the patient had been depressed at intervals, and had threatened to commit suicide.

She had drunk the elixir about mid-morning and was admitted to hospital at 3:30 p. m. She was then deeply asleep but responded faintly to pressure on the supraorbital nerve. Her general condition was good; respiration 20, pulse 72, blood pressure 130/80. Her pupils were normal in size and reacted briskly to light.

On the assumption that absorption was probably complete, stomach

lavage was not carried out. General supportive treatment was instituted and methylamphetamine hydrochloride 30 mg. was given intravenously every half-hour. At 6:30 p. m. she was less deeply asleep, and half opened her eyes when spoken to. Her general condition was good, respiration 21, pulse 72. By 8:30 p. m. she was half awake and making attempts to speak. At 10 p. m. she was able to speak and to answer questions, although still drowsy. At this point the methylamphetamine hydrochloride was discontinued.

During the next day she was somewhat drowsy, but rational and capable of answering questions. By the morning of Oct. 31 she was fully recovered and later consented to have further mental hospital treatment as a voluntary patient.

The single fatality on record is thought to have followed the ingestion of 4.5 to 6 g.

Gusterson[33], anesthetist, Worthing group of Hospitals, Sussex, England, has written a long useful article describing the management of children about to undergo tonsillectomy. The entire article is worthy of study because it contains many practical suggestions. He summarizes his paper thus: It is important to avoid emotional trauma in children admitted to hospital for tonsillectomy, especially when they are under five years of age. Simple points in the management of children during their stay in hospital are outlined. The disadvantages and dangers of using barbiturates for preoperative sedation are outlined. The use of methylpentynol in a flavored elixir preoperative sedation is described. A follow-up to 100 cases showed no difference between the emotional response of those children sedated with pentobarbitone and those receiving methylpentynol. Methylpentynol has a great safety margin and none of the disadvantages of the barbiturates.

W. N. Rollason[34] briefly states seven combinations for tonsillectomy and adenoidectomy in children and the reasons for discontinuing them. While the ideal premedication and anesthetic technique for guillotine tonsillectomy in children has yet to be found, syrup of chloral correctly given, followed by nitrous oxide, oxygen, and trichlorethyline, correctly administered from a McKesson machine is at present, he thinks, the nearest approach to this ideal.

E. H. M. Foxen[35] writes that he is surprised that guillotine tonsillectomies are still being performed in large numbers in the second half of the Twentieth century (circa 1955).

He mentions how Waugh found 143 cases that had already had their tonsils guillotined, some of them as often as two or three times, and concluded that the cause of the failure lies not with the operator but with the type of operation. He voices his agreement with Waugh.

D. Browne[36] agrees with Foxen in his protest against the extraordinary inefficiency of the present removal of tonsils and adenoids in Great Britain.

H. B. C. Sandiford believes that the key to the performance of good and bad tonsillectomy is anesthesia.

J. C. Campbell[39] assures Foxen that it is not just the guillotine method which is responsible for tonsillar remnants, and damage to the faucial pillars, soft palate, etc. If failures occur either the operator has not been taught correctly or is inept. To reverse Mr. Miles Foxen's quotations, surely "the cause of failure lies not with the operation but with the operator."

R. Ellison[37] argues that with proper skill and using a hemostatic guillotine in the majority of children, guillotining is as good as dissection.

J. F. Neil states that the last sentence quoted from Waugh is nonsense. The complete removal of a tonsil with a guillotine is perfectly possible.

Forster[38] is convinced that the most successful instrument to apply in the many cases suitable for its use is the modified double-bladed hemostatic Tonsillatome of LaForce.

Campbell and Smith[39] state that the correspondence which had recently appeared in the *British Medical Journal* (abstracts of this correspondence are printed in this "Tonsil" section) would lead one to suppose that the operation for removal of tonsils and adenoids in children by guillotine and curette under ethylchloride anesthesia was a thoroughly unsatisfactory procedure. This conclusion is entirely at variance with their experience.

They examine every detail of this procedure very fairly and terminate a good paper with the following summary and conclusions:

Guillotine tonsillectomy and curettage of adenoids carried out by an experienced surgeon, under ethylchloride anesthesia administed by a competent anesthetist, is a satisfactory operation. The procedure, as carried out by them is described in some detail, emphasis being laid on the necesssity for a considerable induction of anesthesia. Those who have recorded their objections to the operation base their opinions on an experience of inexpert anesthesia, usually too light. Contrary to widespread belief, the operation requires an anesthesia of considerable depth. The competent anesthetist who is aware of the dangers of ethylchloride, can employ it safely. A recent series of over 12,000 cases without a death is recorded, as contrasted with one of some 25,000 dating from the first quarter of the century in which there were eight deaths.

Crooks[40] carrying on a four year's tradition at the Hospital for Sick Children of dissection of tonsils in all cases, says that he cannot be expected to support the guillotine operation. He requires ten minutes of deep anesthesia, capable of extension exceptionally, for each tonsil and adenoid operation. He is horrified at the frequency of long lateral adenoid remnants causing ear trouble in his patients. More time and care are necessary. Ether anesthesia following ethylchloride induction is as safe and pleasant as ethylchloride alone, and, after all, what is the hurry?

Mawson and Cartwright[41] criticize several details in the article by Campbell and Smith. By contrast; they believe that the essential safety condition of the guillotine operation necessitates light anesthesia; they point out the danger of turning the child on its side after the removal of the tonsils and a leisurely adenoidectomy. They state that the guillotine operation has been abandoned because premedication was considered generally unsafe before guillotining children in large numbers; and finally because modern attention is becoming focussed more on the adenoidectomy and less on the tonsillectomy. Adenoidectomy is far more difficult to do well, and the penalties of an incomplete and inexpert removal are greater, since it is possible to cause permanent deafness through damage to the Eustachian tubes, or by failing to re-

move a cause of Eustachian obstruction and middle ear infection.

TONSILLECTOMY AND ADENOIDECTOMY AND DEAFNESS.

The *Jour A. M. A.*[42] was asked whether the removal of the tonsils would improve the hearing of a four-year-old child apparently hard-of-hearing, and replied that in view of the history given surgical removal of the tonsils and adenoids appear indicated.

Crowe[43] replied to a query regarding tonsils and hearing as follows:

"Our impression in the late 1930's was that the number of adults with impaired hearing could be reduced by 50 per cent if children in the primary grades of our public schools were examined with an otoscope and an electric nasopharyngoscope and properly treated. The routine procedure throughout the country at that time was to test the hearing and send a note to the parents. For financial reasons, often nothing was done for the child. In 1939 we examined with the greatest care 1,365 school children who lived in the Eastern Health District of Baltimore. The hearing of each child was tested on several different occasions in a soundproof room at the Johns Hopkins Hospital. Sixty-seven, or about one in 20 of these apparently healthy school children were found to have impaired hearing for all tones, and some difficulty in understanding spoken words. Many more had lesser degrees of impairment. This study was interrupted by the war.

"A second study of 5,428 third grade school children was begun in November, 1948, and terminated five years later. Screening tests showed that 582 (10.7 per cent) had some impairment of hearing. The hearing of the remaining 4,846 children was good. It is interesting that in this antibiotic era only seven of these 582 children had discharging ears. Recurring attacks of otitis media and chronic mastoiditis were common causes of impaired hearing before the days of sulfonamides and antibiotics. In the second and third decades of the present century, ear and sinus infections were more

frequent than noted above, and I think for that period the 50 per cent prevention figure was not too high."

Barton[44] protested to the *Jour. A. M. A.* that Brown was misquoted or misinformed when he wrote that "Deafness, recurring otitis media, and mastoiditis are rarely improved by adenoidectomy."

Brown[45] replied to the protest as follows:

"In disagreeing with the above statement, Dr. Barton is undoubtedly voicing an opinion generally held; however, my article and *The Journal's* abstract of it would have served little purpose if they had not mentioned the fallacies of the prevailing belief. Many outstanding men believe that progressive deafness, recurring otitis media, and mastoiditis usually are caused by chronic sinustis, and that adenoidectomy not only fails to improve these conditions but may predispose to them. In the original article, 'Harmful Sequelae of Adenoidectomy in Children with Chronic Sinusitis,' *Arch. Pediat.*, 71:233, 1954, there are 64 references and many quotations regarding the protective value of adenoids against the purulent secretions of sinusitis in the production of the above conditions by sinusitis.

"The adenoid protects not only the upper but also the lower respiratory tract. Kaiser's controlled study, now a classic, has shown that removal of tonsils and adenoids increases the likelihood of lower respiratory tract symptoms. As my article states, 'these complications are seen only in children with sinusitis whose protective barrier, the adenoids, had been removed.' It seems neither fair nor open-minded for one to protest a statement appearing in an abstract when he has not read the original article to determine how the conclusion was derived."

Replying to a query regarding the use of radium in the nasopharynx the *Jour. A. M. A.*[46] replied:

"This form of therapy is still very popular, and is producing the desired results in the usual percentage of cases. So far there is no definite evidence to show that carcinoma can result as a late radiation sequel. Some reports show patients

followed as long as 30 years without serious pathological consequences."

POLIOMYELITIS AND TONSILLECTOMY.

A report on the relationship, if any, of poliomyelitis and tonsillectomy[47] has been issued by the Medical Research Council Committee on inoculation procedures and neurological lesions. This report is so detailed and so carefully composed that it should be studied in the original.

It is divided into two parts: one dealing with recent tonsillectomy and the other with remote tonsillectomy. Little more than the summaries of these parts can be given here.

1. Recent Tonsillectomy. Since early in 1951 all medical officers of health in England and Wales have submitted to the Medical Research Council a routine report on each person notified in their areas to be suffering from poliomyelitis. The reports stated whether the patient had undergone tonsillectomy within 12 months before the onset of symptoms and gave dates where relevant. Patients reported to have had their tonsils removed within three months before the onset of poliomyelitis were selected for special investigation, and one of three investigators visited the medical officer of health who notified the case, the physician who was in charge of the patient in hospital, and, in many instances, the patient's general practitioner, and made a detailed record. This is a report of the information obtained about all patients in England and Wales up to the end of 1953, said to have had their tonsils removed within the three months before the onset of poliomyelitis.

Between March, 1951, and December, 1953, complete reports were received of 103 children up to 18 years of age who developed poliomyelitis within 91 days after tonsillectomy.

Sixty-one (59 per cent) had symptoms one to 21 days after tonsillectomy. The concentration was most evident in the bulbar and bulbo-spinal groups where 44 (79 per cent) occurred one to 21 days after operation, compared with 38 per cent of the spinal cases and 31 per cent of the non-paralytic cases.

Most cases occurred in the principal epidemic period, but the same pattern was seen in epidemic and non-epidemic seasons.

Tonsillectomy, as practiced at present, added relatively few to the total number of cases of poliomyelitis reported during the study, but tonsillectomy should continue to be restricted in any area where the disease is unusually prevalent.

2. Remote Tonsillectomy. In the summer of 1951, an investigation was made to determine the importance of the etiology of poliomyelitis of activating agents such as physical activity illness, injury, injections, and surgical operations, including tonsillectomy and dental operations. For all agents except tonsillectomy the inquiry was restricted to three months before the onset of poliomyelitis, but for tonsillectomy a record was made of operations carried out at any time before the onset of symptoms. The investigations were made in Cardiff, the administrative county of Devon, East Anglia, Exeter, Leeds, parts of the administrative county of London, Manchester, and Oxford, and as only a few cases were obtained in 1951, the inquiry was continued until the end of 1952.

Between mid-1951 and November, 1953, records were obtained in selected areas of England and Wales of the history of tonsillectomy at any time before the onset of paralytic poliomyelitis in 51 patients under five years of age and 203 patients five to 15 years of age. Histories were similarly obtained for the same number of matched controls. Only two of the patients and none of the controls under five years of age had had their tonsils removed.

In the five to 15 year age group, 72 (35 per cent) of the patients had undergone tonsillectomy compared with 44 (22 per cent) of the controls. The differences between patients and controls were greatest in the group with bulbar paralysis, intermediate in the group with bulbo-spinal paralysis, and least in the group with spinal paralysis.

In the bulbar and bulbo-spinal groups, most patients had had their tonsils removed at least one year and often five or more years before the onset of poliomyelitis.

The results indicated that persons whose tonsils had been removed were more likely to develop the bulbar form of poliomyelitis than those who had not had the operation, even if years had elapsed between the removal of the tonsils and the onset of poliomyelitis.

Fraser[48] doubts whether it is fair to contrast a group of tonsillectomised children with a control group of average children. The former presumably have a poor resistance to upper respiratory infections, and it would, therefore, be reasonable to expect a more severe attack of poliomyelitis in this group than in a group of average children.

Asked whether it is advisable to perform tonsillectomy and adenoidectomy on children taking the Salk vaccine, the *Jour. A. M. A.*[49] replied: "On the basis of available evidence that tonsillectomy may have a provocative effect on poliomyelitis, it would seem wiser that a child who is to have a tonsillectomy should be given the course of the vaccine before the tonsillectomy is undertaken."

The Jour. A. M. A.[50] was asked when tonsillectomy and adenoidectomy should be performed in relation to administration of Salk vaccine and replied:

"If it is desired to derive what protective influence vaccination may provide before tonsillectomy, then the period when the full protective effect can be anticipated from primary immunization would be 14 days after the second dose, even though it has been shown that in the majority of individuals antibody developes 14 days after the first dose. The interdiction of elective surgery in relation to the administration of poliomyelitis vaccine was applied in some areas during the field trial period. Elective surgery, and more specifically tonsillectomy, should not be performed during periods of poliomyelitis prevalence, but this need not deter tonsillectomy if vaccination is administered when poliomyelitis is not prevalent. It would be hoped that under ideal circumstances a course of poliomyelitis vaccine could be completed before tonsillectomy to take advantage of whatever immunization has resulted from the vaccine. One should not tempt fate by advocating tonsillectomy during the poliomyelitis season even in vac-

cinated children. Efficacy of vaccination was demonstrated under normal circumstances, and not under circumstances of the increased hazard that pertains as a result of tonsillectomy during poliomyelitis prevalence."

MOUTH AND THROAT INFECTIONS.

In diphtheria the antitoxin is very effective in neutralizing the exotoxin formed by the C. diphtheriae, but toxin continues to be produced until the bacteria cease to multiply. All the available antibiotics have some bactericidal effect on the organisms, both locally and systemically. Beach[51] and his co-workers studied the effect of erythromycin on the clinical course and bacterial flora of the nose and throat in acute cases of diphtheria, and in chronic carrier state. In 1953 and 1954 they treated 103 cases, and of these selected 49 for study. The other cases were discarded from the study because of previous medication before coming to hospital.

The 49 patients all had one or more positive nasal or throat cultures for C. diphtheriae with subsequent confirmation by virulence tests. They were treated with erythromycin and diphtheria anti-toxin. All patients on the pediatric service of their hospital who were found to be diphtheria carriers were treated with erythromycin alone. Patients classified as carriers were completely asymptomatic, had no physical findings to suggest active infection, had negative Schick tests and harbored virulent C. diphtheriae in their oropharynx.

Cultures for C. diphtheriae were obtained daily on most patients for seven days, and as long thereafter as necessary until two consecutive negative cultures were obtained. Levels of erythromycin in the sera of 28 patients were determined at intervals during the course of the treatment. Any toxic effect of the drug was noted.

It was found that C. diphtheriae was eradicated in all patients after completing treatment. The average time was two days in the active cases and three days in the carrier state. One patient died from toxic myocarditis. In the treatment of diphtheria erythromycin appears, on the basis of this study to be the most promising antibiotic to date.

Erythromycin is advocated as an adjunct to and not as a substitute for antitoxin in the treatment of acute diphtheria.

The *Jour. A. M. A.*[52] was asked for diagnosis and treatment of tenacious pseudomembrane formation over the adenoids which was unresponsive to chemotherapy: 27 cases with this condition had been seen, three of them in children. The reply was that mononucleosis and lymphatic leukemia should be considered, but emphasized that diphtheria was a strong probability in spite of the negative cultures.

NASAL OPERATIONS.

Wexler[53] states that indications for surgical correction of the deviated nasal septum in children are nasal obstruction, chronic sinusitis, epistaxis and deformity of the nose after severe trauma. He emphasizes that only those portions of the nasal septum that are responsible for the presenting condition are removed.

Comment: Your reviewers admit that submucous resection of the nasal septum is necessary in some children. They feel, however, that very many children will have their septums operated upon if the indications of Wexler are followed, and point out that some of such interferences will be unnecessary and ultimately very unfortunate for the patient. Every child on whom submucous resection of the nasal septum is considered should be referred first of all to a rhinologist of long experience.

Gollom[54] discusses nasal fractures in both children and adults, their anatomical and pathological factors, their classifications and the management by the conventional closed method.

The anatomical problem in children is slightly different from that in adults. The nasal bones are separated by a suture line; the bones are softer, the cartilages thinner. With injury the bones may spread apart or the cartilages tear easily. Radiography may reveal soft tissue edema and nothing more. The septal cartilage may, with injury, buckle and spring from the vomerine groove, becoming dislocated into either the right or left nasal passage.

It is easy to overlook nasal fractures. In children particularly the rapid symmetrical swelling which may occur obscures the basic deformity. Palpation of a depressed bone is less certain. The intern in his hospital emergency department, or the family doctor, may be unaware that 40 to 50 per cent of nasal fractures will not show up on radiographs. A negative report gives the doctor who first sees the patient a false sense of reassurance. Four weeks later the patient or his family becomes convinced that a deformity really exists. By this time a relatively minor condition has changed into a major problem, due to bony union or scar tissue formation and contraction.

Reduction, where feasible, is best undertaken immediately after the accident. Where edema is considerable, reduction may be postponed for several days. Children require a general anesthetic. Manipulation and elevation of fragments will often accomplish disimpaction and reduction at the same time.

Following reduction of the fracture the nose is packed for four or five days and an external splint is applied and kept on for seven to ten days.

He also comments on the open rhinoplastic approach to more complicated nasal injuries.

Comment: It is the reviewer's opinion that an external splint prevents observation and that packing, in spite of antiseptic ointment, produces headache and perhaps infection. He prefers to do without either. He does favor putting restraining armlets on the child and at night preventing the child from rubbing its nose against the pillow.

TUMORS.

A case report of a thymic tumor of the pharynx is presented by Epstein and Loeb[55]. The presence of thymic tissue above the thyroid gland is rare, and the explanation is due to the fact that the thymus originates from the third and fourth branchial clefts.

The patient was a three-week-old infant in whom the mother

noted the appearance of a mass protruding from the mouth when the baby regurgitated. It had the appearance of a second tongue, being about 1 cm in diameter. The mass projected from the mouth for a few minutes, then disappeared into the mouth. X-ray examination with barium showed the mass to be alternately swallowed and regurgitated. The base of the mass was seen to be in the medial portion of the left pyriform sinus. The mass was removed with a nasal snare after a ligature was tied around the pedicle. The pathological report showed a mass 3.5 cm. long and 1 cm. in diameter. Cross section showed the interior to be made up of cords of yellow tissue set in pink membrane. Sections showed a polypoid structure consisting of isolated groups of thymic tissue containing Hassall's corpuscles.

A case of teratoma of the tonsil in the newborn is reported by Baugh and O'Donoghue[56]. The tumor produced respiratory obstruction, and at birth the infant was in a state of asphyxia pallida, and remained so after large amounts of mucus were extracted. There was some improvement in color after the administration of oxygen and 7 per cent CO-2, but breathing remained difficult. Further examination at this time revealed a tumor protruding from the posterior surface of the left anterior pillar of the tonsil. The growth was obstructing the pharynx entirely. An emergency enucleation of the tonsil was carried out with a tonsil guillotine, and breathing became much easier. There was some trouble with hemorrhage which was finally controlled, but the baby died about 36 hours later.

The pathological report showed a tumor mass consisting of a tonsil and two polypi projecting from the external surface. The larger polypus measured 15x10 mm., and the smaller one 10x3 mm. The tonsil measured 20x10x15 mm., and on section showed bony, cartilaginous and other white tissues. Histological examination showed a disorderly mixture of cartilage, cancellous bone, plain and striated muscle, neuro-epithelium, and renal and adipose tissues, together with clumped masses of cells which included lymphocytes, plasma cells, eosinophiles and multinucleated giant cells. A diagnosis of teratoma was made.

The author believes that this is the first case reported of a teratoma arising in the tonsillar fossa.

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ANNUAL ASSEMBLY IN OTOLARYNGOLOGY.

The Department of Otolaryngology, University of Illinois College of Medicine, announces its Annual Assembly in Otolaryngology from October 1 through 7, 1956. The Assembly will consist of an intensive series of lectures and panels concerning advancements in otolaryngology, and evening sessions devoted to surgical anatomy of the head and neck, and histopathology of the ear, nose and throat.

Interested physicians should write direct to the Department of Otolaryngology, 1853 West Polk Street, Chicago 12, Ill.

AN EVALUATION OF THE PSYCHOGALVANIC SKIN-RESISTANCE TECHNIQUE IN AUDIOMETRY.*†

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Accurate determination of hearing loss in the very young child, and in certain adults, is a challenge to the otologist. Only with accurate determinations can our knowledge of the etiology of hearing damage be advanced or the proper plans be laid for the rehabilitation of these patients.

Hard-of-hearing children do not develop along the same lines as their chronological counterparts with normal hearing.[1] Without the natural means to communicate, learning becomes a very complicated and slow process. Such deviant development frequently obscures the clinical picture, even masking the basic handicap of hearing loss. Many of the children under the age of five years, seen in large clinics, are brought in with the admission diagnosis of "mental retardation", "aphasia", or "autism".

Children with partial hearing, especially those with residual hearing only for the low tones, suffer from failure to comprehend conversation or to develop speech; but at the same time it is evident to close observers that these children can hear. Speech being mere imitation of what one hears, a child with such a handicap cannot hope to produce much more than a series of "grunts". His communication being thus reduced to almost an animal level it is not surprising that many of them are stigmatized as mentally deficient and so denied the chance of early rehabilitation.

Adults suffering from various types of psychic trauma, or of brain damage, make up a smaller group of patients that present, with respect to testing hearing, a similar problem to

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that of the very young child. Subjective tests are unreliable. Even in those instances where malingering tests show the subjective test inaccurate, the problem of establishing accurate thresholds still remains.

Standard hearing tests used in diagnostic work in adults are inapplicable to the problems of the young, hearing-handicapped child and the adult with psychic trauma or brain damage, because they depend primarily on the voluntary cooperation of the examinee.

To obtain diagnostic information on the hearing status of deafened young children, four types of tests had been evolved by 1947: *1.* the use of various noise makers; *2.* speech audiometry; *3.* play audiometry; *4.* changes in electro-encephalograph records under the exhibition of a test tone.

The use of noise-making toys, which has been employed for many years,[2,3,4,5] reached a very refined state in the hands of the Ewings and Utley. They, separately, developed a set of calibrated noise makers which they used for testing; at times they substituted pure-tones during the test situation. Their accurate observations led to many successful determinations of hearing loss. Myklebust used a variation of this technique in his clinic. Such tests closely approach Play Audiometry. Their chief handicaps are: *1.* in many instances a response to vibration may be elicited as well as, or instead of, an auditory response; *2.* such tests are basically bilateral in character; *3.* it is seldom possible to make accurate determinations for thresholds of pure tones, and often impossible to distinguish where in the sound spectrum the greatest loss of hearing occurs.

Speech audiometry was used successfully by Keaster[6] and others[7,8] before 1947. By its use much information can be obtained about these children, whose speech development permits even limited communication. The difficulties encountered in using this technique result not only from its dependence upon cooperative communication, but also from the fact that it gives no information about the pure-tones involved or their individual thresholds.

Play audiometry reached its present excellence when Dix and Hallpike[9] developed the "Peep Show". Here a child is con-

ditioned to press a button when he hears a pure-tone in order to be rewarded by the sight of an interesting picture. In expert hands and working with cooperative children this has proved an accurate and very satisfactory technique. Success here depends entirely upon the active cooperation of the examinee. The principal difficulties encountered have been *1.* with children under three years of age; *2.* with children suffering from psychic trauma; *3.* with those children with brain damage. Especially notable in this latter group is the child suffering from cerebral palsy.

Michels and Randt[10] in 1947 reported changes in the electroencephalograms of adult patients stimulated by pure-tones. Similar work was also reported by Marcus, Gibbs and Gibbs[11] in 1949 working with young children. The problems encountered in using this technique are: *1.* repetitions of the sound stimulus result in gradual disappearance of "response changes" in the tracings; *2.* the stimulating tone has to be delivered at a considerably greater intensity than the actual threshold in order to obtain a response; *3.* some tones in the sound spectrum produce better responses than others.

In an effort to obtain information on the hearing of adults and children who could not be satisfactorily tested by the foregoing techniques, Psychogalvanic skin-resistance (PGSR) audiometry was first attempted at the Johns Hopkins Hospital in 1947. This method of testing is based on the Pavlovian conditioned reflex.[12] Such a reflex had been demonstrated by Pavlov[13] before 1912. He repeatedly fed dogs soon after sounding a tone. After sufficient repetition of this sequence, the dogs would salivate at the sound of the warning tone in anticipation of the feeding. This was a sympathetic nervous system response to an auditory stimulus.

The changes in skin-resistance to the passage of a small electric current following sensory, or emotional stimuli, were first demonstrated in 1888 by Feré.[14] In 1928 Richter[15] developed a technique whereby he was able to record graphically the qualitative changes in skin-resistance following stimulation of the sympathetic nervous system by an electric shock. For this determination he used a delicate Wheatstone bridge in circuit with a direct current millivolt amplifier, coupled with a graphic

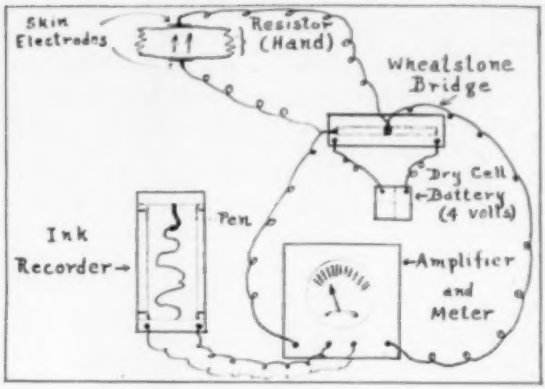

Fig. 1. Schema of the circuit used to record changes in skin resistance.

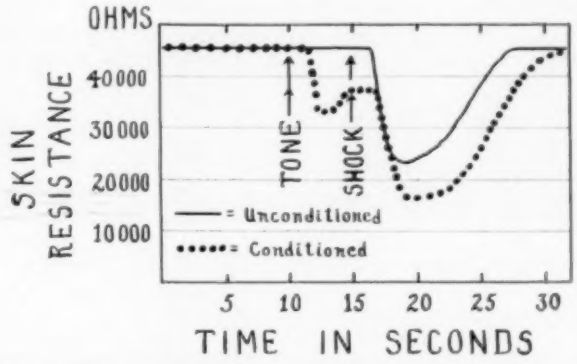

Fig. 2. Diagrammatic graph of the changes in skin resistance in a person before and after conditioning to a tonal stimulus.

recorder. The shock device was a Harvard inductorium with which the intensity of the shock could be varied. Richter's technique consisted of adjusting the Wheatstone bridge so that the least current possible was passed through the skin, usually of the order of 2-20 microamperes. The patient was then mildly shocked, which resulted in a sympathetic stimulus. This caused increased activity of the sweat glands and a lowering of skin-

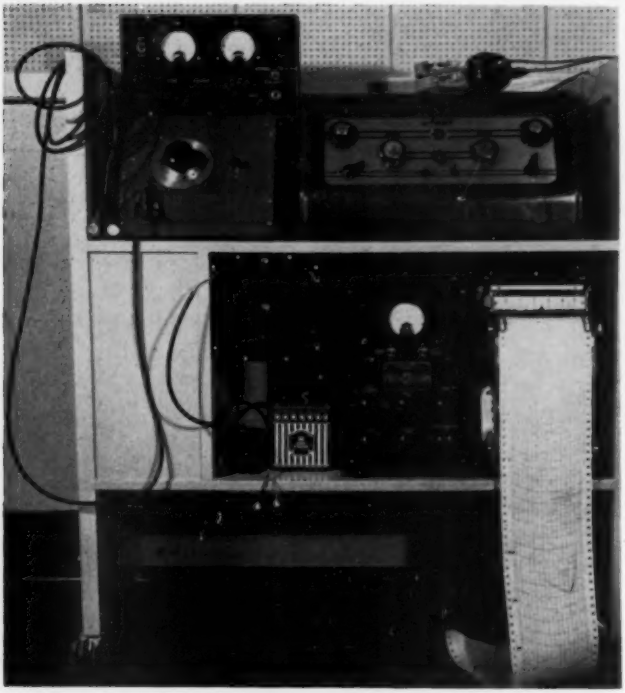

Fig. 3. The apparatus used in PGSR audiometry. The shock device and the audiometer are above the Wheatstone bridge, the amplifier and the inkwriter.

resistance. Such skin-resistance changes were amplified and recorded.

The PGSR technique of testing hearing acuity employs Richter's equipment,[16] adding to it a standard audiometer. A pure-tone from the audiometer, through the headphone, is used as a warning signal of the coming shock, which follows in approximately five seconds. After the warning tone-shock sequence is repeated for several minutes the patient develops a sweating response after the sound in anticipation of the coming shock. When this occurs, the patient can be said to have developed a "conditioned reflex". Thereafter, as long as the patient hears

a warning tone there is a drop in skin-resistance before the shock. When the tone is not heard the patient receives no warning of the coming shock, and there is no premature sweating response (see Figs. 1 and 2).

Fig. 3 shows the skin-resistance audiometer. Fig. 4 shows the test situation. The shock electrodes will be noted on the leg and the skin-resistance electrodes can be seen on the finger

Fig. 4. The test situation. The shock electrodes are on the right calf, the skin-resistance electrodes are on the left hand.

tips. The shielded shock device and standard audiometer are placed above the Wheatstone bridge, the amplifier and recorder.

Fig. 5 represents an actual tracing of a patient who has been conditioned and whose threshold is being determined for the frequency of 1024 cps. It can be seen how the premature response occurs before the shock, and how, when the tone is dropped below threshold, the skin-resistance changes only after the shock.

Long experience with this method has shown that once an

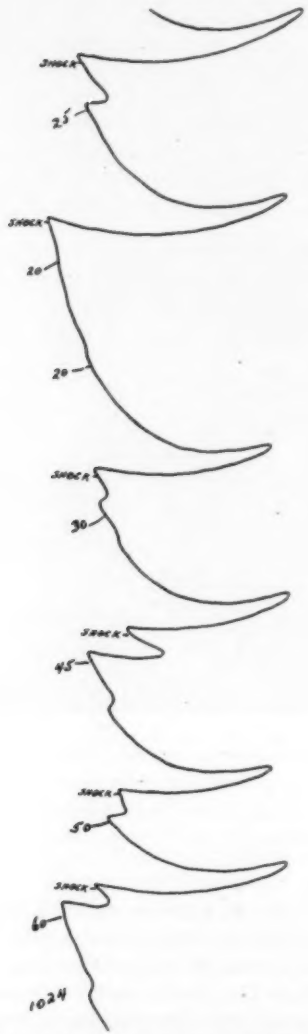

Fig. 5. An actual tracing obtained during PGSR audiometry, illustrating the method of determining the threshold value for a pure tone in a subject in whom a conditioned reflex has been established.

individual is conditioned for one pure-tone he is conditioned for tones in all octaves which may be used in the test in either ear.[17] Such conditioning lasts approximately 30 minutes after completion of the testing. Unless the shock is kept at a noxious level there is a general tendency for conditioning to fade when the test is carried on over a prolonged period of time. This may require increasing the intensity of the shock several times during a test. A masking sound may be used in the opposite ear without invalidating the test.

By using this method thresholds can be plotted on a normal audiogram form just as in subjective audiometry. The period of time necessary for conditioning varies with each individual. Usually it can be accomplished within ten minutes. The length

TABLE 2. Comparison with adults (10 ears) between standard and galvanic skin-reflex audiometry for four test-tones.

	500 cps	1000 cps	2000 cps	4000 cps
Variance of mean	3.41	2.66	1.51	2.56
Standard deviation	4.01	4.70	5.01	4.00
Differential range of 5 db. or less	75%	70%	60%	62%

FIG. 6.

of time to obtain an audiogram usually ranges from 20 minutes to an hour. One hour should be the limit for such testing; because after that period the subject becomes extremely tired, and the complicating factors of sleep and exhaustion enter the picture.

How Accurate Are Such Audiograms? For the first three months this method was employed it was used only on adults, and whenever a PGSR audiogram was made it was followed by a subjective audiogram. Individuals chosen for such studies included normal to extremely hard-of-hearing patients. Records on 30 ears of 20 individuals with impaired hearing revealed an average difference of less than five dbs between subjective and objective audiometry throughout the sound spectrum (see Fig. 6).

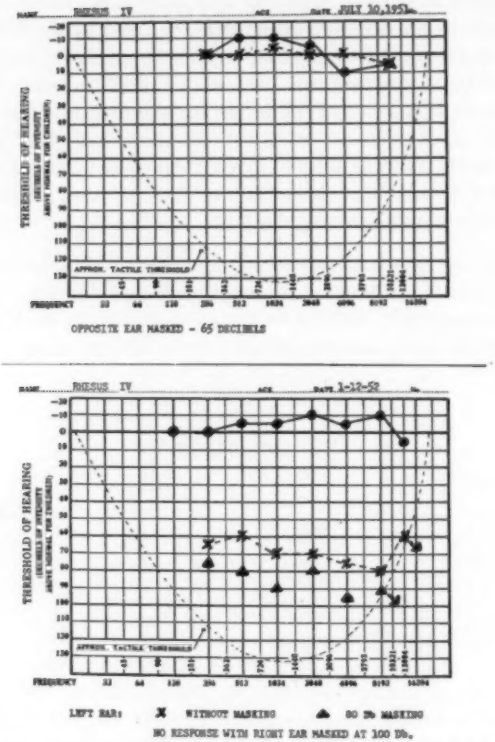

Fig. 7. PGSR audiograms obtained from a rhesus monkey before and five months after a complete section of the left auditory nerve.

What Is Being Tested by the PGSR Method? The end-organ for this reflex lies within the ear, and the responses obtained are not the reaction to some tactile stimulus. This fact has been demonstrated by sectioning one auditory nerve of a previously tested Rhesus monkey, allowing the monkey to make a complete physical recovery and retesting his hearing. The unoperated ear gives a normal audiogram, while the ear in which the auditory nerve has been sectioned, when the other ear is properly masked, gives no response to auditory stimuli (see Fig. 7).

The localization of the region in the brain for the mediation of this reflex is, as yet, unestablished. Pavlov[13] in 1912 theorized that the site of such a conditioned reflex must lie within the cerebrum. It is now thought that there may be several levels in the brain at which this reflex may be mediated. For this type-testing the lowest level of communication between the auditory pathways and the sympathetic nervous system, would seem to be of great importance. Injury to auditory pathways or auditory projections above the lowest level of crossover, might not reflect itself in such a conditioned reflex audiogram.

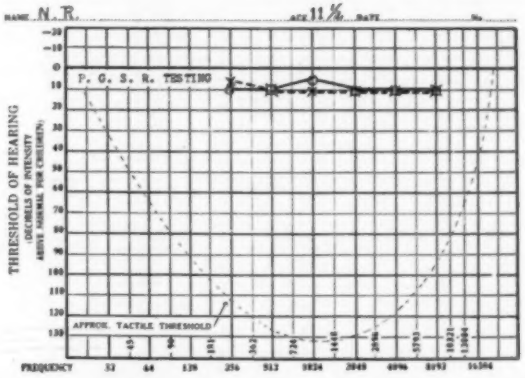

Fig. 8. PGSR records of the hearing of an 11-year-old boy suffering from severe brain damage at birth, with psychometric classification at the idiot level. By other tests he showed no evidence of hearing.

In 1948 Bromily[18] reported that he had been able to develop a conditioned response in a decorticate dog. The animal retained the power of discrimination between light and sound. Wang and Nager[19] have recently conditioned a decorticate cat to two types of auditory stimuli (bell and buzzer) by the PGSR method. In 1954 Wang, working in Richter's laboratory, performed some as yet unpublished experiments, in which he abolished the shock-sweat reflex in cats by transection of the brain from the intercollicular level to the rostral border of the pons. Transection above this level did not abolish the reflex. It would seem then, that the auditory-sympathetic reflex

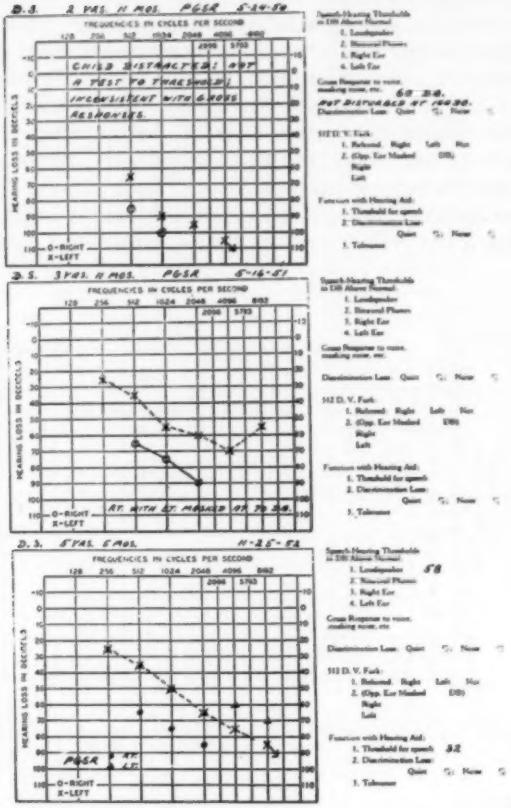

Fig. 9. Example of the "stabilization" of hearing levels of a young child after repeated tests by PGSR audiometry. (2nd audiogram). Comparison of PGSR values for left ear with standard audiometry 18 months later. (3rd audiogram).

must lie somewhere below the cortex and above the level of the inferior colliculi and the rostral border of the pons.

That such an audiogram represents a test of the efficiency of the auditory end-organ rather than any comprehension of sound is further demonstrated by the little boy, age 11 years (see Fig. 8), suffering from severe brain damage as the result

of birth injury, severe prolonged anoxia and multiple postpartum convulsive seizures. He did not walk until he was three-and-a-half years old, and even at 11 he had a wide unsteady gait. He was not toilet trained, and would feed himself only occasionally, using his hands instead of a spoon. He had marked disturbances in his electroencephalogram. He was at the idiot level by psychometric evaluation. He had developed no speech. He occasionally would turn his head toward some new sound. He gave no satisfactory response to standard hearing tests, yet by PGSR audiometry his hearing was normal.

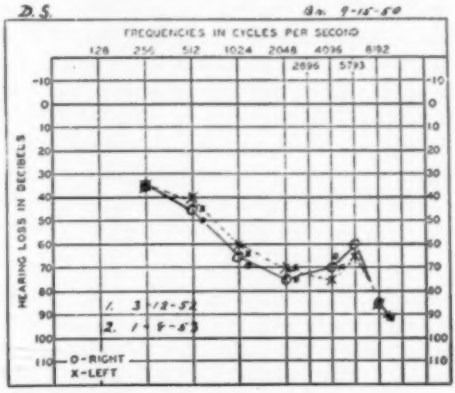

Fig. 10. The test-retest PGSR audiograms of a child who was first tested at 19 months of age, and again at 28 months.

He had no hearing in the broadest sense of the word, but his end-organ function was unimpaired. His reception was unimpaired, but his perception was destroyed.[20]

It is felt that when testing children the initial audiogram represents hearing at least as good as the thresholds obtained. We do not consider this the true threshold, however, until we have obtained at least two audiograms on separate occasions that average within five dbs of each other. To obtain such determinations has occasionally required as many as three or four test periods (see Fig. 9). Each succeeding test in these children shows an improvement.

Such improvement subsequent to initial testing has also been noted by Barr[21] in both play audiometry and psychogalvanic audiometry. The Ewings[22] in a follow-up study of the hearing levels of a group of children whose thresholds had been established by their "Toy Tests" found that no child tested worse than his first level. A number of the children were found to have better thresholds in the follow-up tests. This variation is seen more frequently in younger children under three-and-one-

TABLE 3. Test-retest comparison with children (86 ears) for four test-tones with galvanic skin-resistance audiometry. Age-range, 1-9 years; mean age, 3.7 years.

	500 cps	1000 cps	2000 cps	4000 cps
Variance of mean	3.72	2.44	1.97	2.91
Standard deviation	5.21	3.23	4.27	4.58
Differential range of 5 db. or less	62%	52%	55%	62%

Fig. 11. Statistical evaluation of test-retest values on 86 ears of children ranging from one to nine years.

TABLE 1. Comparison with children (59 ears) between standard and galvanic skin-resistance audiometry for four test-tones. Age-range, 4-18 years; mean age, 8.1 years.

	500 cps	1000 cps	2000 cps	4000 cps
Variance of mean	3.22	3.75	3.66	3.77
Standard deviation	4.66	5.19	3.98	3.69
Differential range of 5 db. or less	67%	61%	71%	49%

Fig. 12.

half or four years. It is also more likely to occur in the presence of some brain injury. Once the threshold has been established the test-retest picture has proven satisfactory (see Figs. 10 and 11).

In very young children it is impossible to make objective-subjective cross checks on audiograms. Standard pure-tone audiometry is rarely reliable under six years of age. A series of 59 ears on 39 children ranging from four to 18 years, and averaging eight years, were studied by Hardy and Bordley[23]

by PGSR and standard audiometry. Deviation was less than 5 db in from 61 to 73 per cent of the tests at 500 cps., 1000 cps. and 2000 cps. The average of deviations shows that the threshold for PGSR is slightly lower than that obtained by standard audiometry (see Fig. 12). These data are slightly at variance with the reports of Barr,[21] Faure,[24] and Maspitiol[25] in similar groups of children.

Barr states that standard audiometry is about 5 db below thresholds obtained by PGSR. Faure reports in his series that true thresholds lie about 15 db below PGSR thresholds in examinees between two-and-one-half and four years, and about 10 db below in the four to seven year group. Maspitiol, Gougerot and Korine observed a 15 to 20 db discrepancy against PGSR thresholds in the children they studied between four and eight years of age. Barr in his recent monograph states that thresholds established by play audiometry and PGSR audiometry, once they have become stabilized, showed substantial agreement. Less than 15 per cent of the audiograms showed more than 5 db difference when checked by both methods, in a group of 68 children from two to six years old.

What Is the Earliest Age at Which Such Audiograms Can Be Attempted? Here again it depends on the individual. In general by the age of 18 months, testing a child without severe brain damage, should be relatively free from difficulty. Younger than this the child's skin-resistance seems to increase, and the sympathetic response becomes slower. In many instances we have encountered in the child of six months, a skin-resistance so great that our Wheatstone bridge, which is capable of handling up to 300,000 ohms resistance, cannot overcome it. We have successfully tested many children less than one year old, but failure increases greatly under 18 months of age. Such increased difficulty was also noted by Barr, who stated that he could not anticipate success in establishing thresholds by PGSR audiometry in more than 50 per cent of patients under two-and-one-half years of age.

LaBenz,[26] in using this technique experimentally on newborn infants, has found that the sympathetic response to shock in them is very greatly slowed down, resulting in a much greater time lag between stimulus and response. He also found

the most active sweat glands to be on the head, instead of on the hands and feet. Altogether he studied 41 children averaging 134 hours old and was able to elicit responses to sound stimulation in 32 per cent. No attempt has been made to interpret these responses as thresholds, or to consider them as conscious levels of hearing.

What Difficulties and Failures Are Encountered in Using PGSR Audiometry to Test Children? As with almost any type of technique to test hearing, failures have been encountered when using this method. Difficulties have been encountered in conditioning some children. In a high percentage of cases difficult to condition, follow-up studies have subsequently shown evidence of brain injury. Difficulty has been encountered in evaluating records on athetoids and spastic children because of the many false positives due to extraneous bursts of sympathetic stimuli in these children.

One of the greatest problems is for the test personnel to maintain an "objective attitude". Some of the worst mistakes have resulted from the tester distorting the interpretation of questionable tracings to fit his preconceived ideas. Goldstein[27] has also emphasized this weakness. When records are not clear they should be discarded. The incidence of such failures is certainly not over four to five per cent, which we feel is not sufficient to invalidate the method.

The percentage of failures has steadily decreased as we have improved our techniques in handling the child in the test situation. This is extremely important and can be done by a well-trained team, which through experience can keep the child relatively quiet and fairly well occupied during the tests.[28] Many children have to be retired from the test situation and allowed to take a nap, or even get a night's rest, when they become severely disturbed; but with a well-trained team that is willing to devote unlimited time to a child, success is the rule rather than the exception. Few children show serious fear disturbances when the test situation is properly handled. Barr in his series found that less than 5 per cent showed disturbing signs of fear.

PGSR audiometry has been employed in the hearing studies

of over 1600 adults. Many of these patients have been examined to obtain validating studies on the PGSR method, but more than 400 have been tested by this technique because there was reason to question the accuracy of the standard subjective audiometric findings. As a group adults are far easier to condition and test than children. It is thought that such ease of testing results from the fact that the method acts as a "lie detector" as well as a conditioner. The problem of stabilizing the threshold of response to a tone does not seem to present itself in adults as in young children.

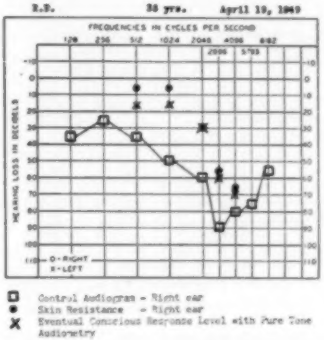

Fig. 13. Standard and PGSR audiograms of the right ear of a 36-year-old woman with a "psychogenic overlay." Note that a repeat subjective audiogram, done after the PGSR study, showed marked improvement.

The first audiogram is usually correct. Failure to establish satisfactory hearing levels has occurred in less than 2 per cent of the patients examined. Two complete failures occurred in testing two individuals suffering from a deep catatonic state. It has been used successfully in four general groups of patients: *1.* those suffering from some "psychogenic overlay" (see Fig. 13); *2.* malingerers (see Fig. 14); *3.* those adults with severe hearing loss who have grown up in a deaf atmosphere such as a "signing" school situation, and who as a result have never developed any ability to listen (see Fig. 15); *4.* persons with certain types of brain lesions.

This latter category is of particular interest, as it offers a different diagnostic use for PGSR. It is comprised of older

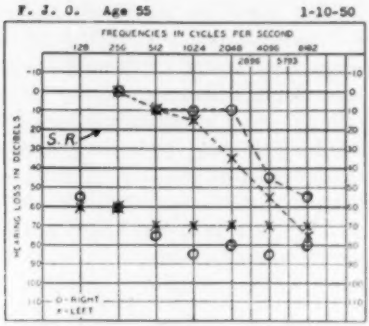

Fig. 14. Standard and PGSR (SR) audiograms of a 55-year-old man seeking compensation for an old head injury.

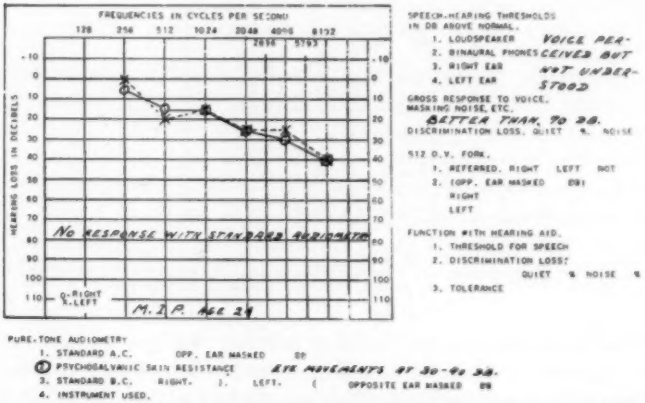

Fig. 15. PGSR audiogram of a 24-year-old woman, raised from infancy as a deaf child, educated in a deaf school environment. She had good speech, but gave no responses to standard audiometry.

adults. By subjective hearing studies they appear to be satisfactory candidates to wear hearing aids, yet they have never been successful in their efforts to use them. Such individuals are familiar to every Hearing Center and offer a very baffling problem to otologist and audiologist alike.[29]

A group of 20 of these patients have been under study by Bordley and Haskins[20] for the past two years. They have been

tested repeatedly by standard subjective pure-tone audiometry, PGSR and speech audiometry; they have all been individuals distinguished by success in their chosen fields of work. In each case the hearing difficulty has arisen in the preceding two to four years. They feel that they can hear quite well, but can no longer discriminate words. The problem is greatly accentuated in group communication, or whenever the listening situation becomes complicated.

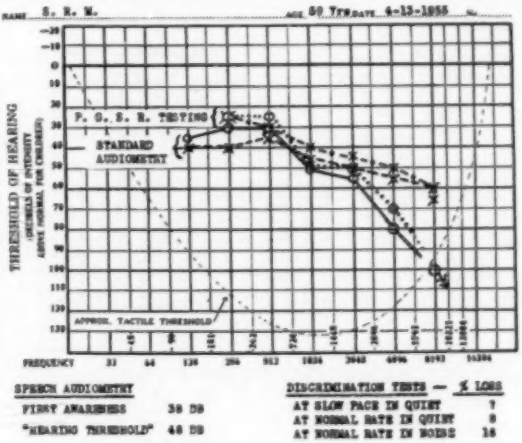

Fig. 16. Standard, speech, and PGSR audiometric data of a 59-year-old man, who uses a hearing aid successfully.

Their hearing tests have the following in common:

1. The PGSR audiogram indicates significantly better hearing than does the standard subjective audiogram.

2. Thresholds in decibels by speech audiometry for awareness of sound and for understandability of speech are much further separated than in those persons using amplification successfully.

3. Ability to understand single simple words when spoken slowly is good. As the speed of delivery is increased there is an abnormal breakdown in the understanding.

4. Discrimination breaks down abnormally in noise.

A comparison of the hearing test records of a successful hearing aid user with one of the study group will highlight the significant difference in the responses (see Figs. 16 and 17).

The consistent difference between PGSR audiometry and standard audiometry in all of these patients is significant. PGSR audiometry has been shown to be dependent upon the

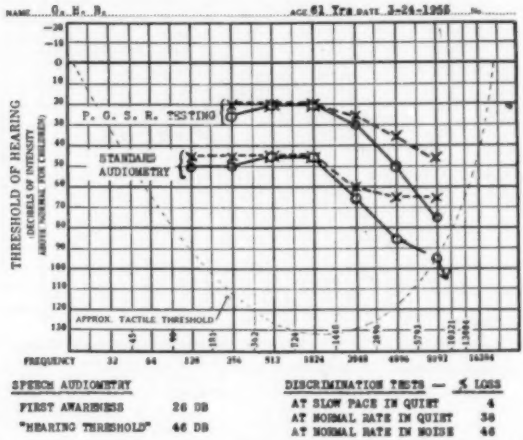

Fig. 17. Standard, speech, and PGSR audiometric data of a 61-year-old man, who has suffered repeated failures in attempts to use a hearing aid.

intactness of the auditory end-organ and auditory pathways at least up to the level of the colliculi, but does not seem to require an undamaged cerebral cortex. Standard pure-tone audiometry, depending upon subjective responses, would seem to require not only an intact auditory end-organ and nerve but also undamaged higher pathways, and cortical projections.

The difference then, between the two types of tests in this group of individuals who have poor discrimination, a poor standard audiogram, and a good PGSR audiogram, would point

to some damage to the higher auditory pathways. Such damage does not interfere with sound reception but rather to its perception. Such damage would seem to be cerebral, probably in the cerebral cortex.

Such a theory is supported by the work of several animal experimenters. Babkin[30] working under Pavlov in 1911, reported tests on a dog which survived three years after removal of the posterior portion of the cerebral hemispheres. Before operation the dog had been conditioned to sequences of sounds, but after operation he could never be taught to discriminate between tones. In 1912 Pavlov[13] observed "From the standpoint of the conditioned reflexes the cerebral hemispheres appear as a complex of analyzers whose functions are: to decompose the intricacy of the outer and inner worlds into their separate elements and components; and further, to connect all of these with the manifold activity of the organism." Meyer and Woolsey[31] in 1952 reported that after bilateral ablation of the auditory cortex some animals could be conditioned to respond to a sound but could no longer discriminate between frequencies. Diamond and Neff[32] in 1953 reported that cats after bilateral ablation of the auditory cortex lost the ability to discriminate between tones. All these experiments indicate that damage to the auditory cortex results in damage to auditory perception, rather than to auditory reception.

The theory that those individuals with poor discrimination, poor subjective audiograms, and good PGSR audiograms are suffering from damage to the auditory cortex rather than the auditory end-organ and nerve, will also explain a group of cases that have previously been reported in the literature. In 1934 Crowe, Guild and Polvogt[33] reported a group of ears which showed no pathology in the end-organ or auditory nerve, although standard pure tone audiometry had revealed a nerve type hearing loss. In 1937 Fieandt and Saxen[34] reported similar findings. In 1955 Schuknecht[35] added to this growing list and suggested, as had Crowe, that such hearing losses might be the result of central auditory pathway lesions. He went further in his speculation and theorized that degeneration of second, third and fourth order neurons might be significant in old-age deafness.

PGSR audiograms on these individuals might well have been much better than the standard audiograms, thus pointing to a possible cortical damage.

DISCUSSION.

PGSR audiometry would seem to measure only the efficiency of the auditory end-organ and the subcortical auditory pathways, while standard audiometry measures the efficiency of the hearing mechanism as a whole from the external ear through the auditory cortex. It evaluates the reception rather than the perception of sounds. This difference should always be borne in mind in the evaluation and interpretation of the findings of PGSR studies. The more limited function of PGSR audiometry has great advantages over the standard methods of pure-tone audiometry, speech audiometry, and play audiometry in certain instances.

Children under six years of age cooperate so poorly[36] that under even good circumstances standard audiometry is so unreliable as to be rejected by a majority of those most versed in evaluating their hearing. This would reduce pure-tone audiometry to two methods, play audiometry, and PGSR audiometry. Play audiometry, where there is good cooperation and enough communication, offers certain definite advantages; it tests the whole hearing mechanism. In situations where hearing determinations are necessary in the brain-injured child who cannot cooperate, such as in cerebral palsy, in the child whose hearing loss has delayed his ability to communicate, or in the child under three years of age, PGSR audiometry would offer a logical solution.

It seems to be true in all types of hearing determinations in young children, that retest is required to establish a stabilized threshold. In some cases the exact measurement of hearing cannot be established for a matter of months or longer; nevertheless, because a child's ability to learn the communicative skills seems to be optimum in the period between one and four years, the importance of the early hearing evaluation cannot be too strongly stressed. In all hearing evaluation in young children one should keep in mind the difference between apparent and potential thresholds.

Some children whose hearing is evaluated by PGSR audiometry and found to be satisfactory may eventually manifest evidence of brain damage. This danger is always inherent in a test that does not evaluate the hearing mechanism as a whole; but such a test has the inestimable value of establishing whether the deviant development of a child is the result of some peripheral lesion or a more serious and probably more pervasive central lesion.

The chief difficulties encountered in testing the hearing of children by PGSR are found: *1.* in establishing conditioning in the presence of certain brain injuries; *2.* in the building of a team capable of handling the test situation; *3.* in the unbiased interpretation of the skin-resistance tracings.

The need of PGSR audiometry in adults is more limited, although its technical difficulties are fewer than those encountered in children. The categories of psychoses and malingering have been under investigation by the PGSR technique in several University clinics and in the audiology section of the Veterans Administration, and the findings have warranted its continued use. Combining standard and speech audiometry with PGSR audiometry would seem to offer a method for study of damage to the auditory pathways in the cerebrum and the auditory cortex.

CONCLUSION.

It is our considered opinion that PGSR audiometry offers a valuable adjunct to other methods for hearing evaluation. It is particularly useful in studying the hearing of young children and certain adults. It measures reception rather than perception of sound. For objective determination of thresholds of hearing for pure-tones, it offers a clinically practical approach. It can be employed in the animal experimental laboratory. It does not necessarily evaluate hearing at the cortical level. Its accuracy is greatly enhanced when it is undertaken by highly trained personnel. It is not yet free from failure, and probably never will be.

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SIXTH INTERNATIONAL CONGRESS ON OTOLARYNGOLOGY.

The deadline for submitting titles of papers and films for presentation at the Sixth International Congress of Otolaryngology is Oct. 1, 1956. Requests for places on the scientific program must be received before that date together with an 800-word abstract of the paper. Applications and abstracts should be sent air mail to the General Secretary, 700 N. Michigan Ave., Chicago 11, Ill., U. S. A.

SIGNIFICANCE OF OTOLOGIC FINDINGS IN CEREBELLOPONTINE MENINGIOMA.*

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REVIEW OF THE LITERATURE.

In 1922, Cushing[1] proposed the term "meningioma" to designate a group of tumors originating from the meninges of the brain and spinal cord. Meningiomas are slow-growing tumors originating from the "cap cells" (meningiocytes), which tend to collect in clusters around the tips of arachnoid villi and are derived from the neural crest.[2] These tumors rarely invade cerebral tissue but push it aside. They may become extremely large and may be present for many years before producing clinical evidence of intracranial disease.[2] Kernohan and Sayre[2] considered that 36 of a series of 370 intracranial meningiomas were malignant. They stated that these tumors practically never give rise to metastasis either within or outside the cerebrospinal axis. Their criteria for malignancy were purely on histologic grounds. Meningiomas may come in contact with the skull and produce changes that lead the roentgenologist to suspect the identity of the disease.

Meningiomas make up a considerable percentage of all intracranial tumors. In the experience of Shelden and Adson,[3] this figure was 15 to 25 per cent, whereas in that of Horrax and Strain[4] it was 14.6 per cent and in that of Cushing[5] it was 13.5 per cent.

Kernohan and Sayre emphasized the several loci of predilection of meningiomas. Of their total of 794 cranial meningiomas, 184 were parasagittal, 73 were attached to the sphenoidal ridge, 26 were found in the basofrontal region or the olfactory groove, 61 were around the sella turcica, and 55 were found

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at the cerebellopontine angle. In a similar study of 313 such tumors, Cushing and Eisenhardt[6] stated that 65 were parasagittal, 56 were over the free convexity, 53 came from the sphenoidal ridge, 29 came from the olfactory groove, 28 were suprasellar, 23 were in the posterior fossa, and lesser numbers originated elsewhere in the meninges.

Hamby[7] described two patients who had trigeminal neuralgia due to contralateral meningiomas of the posterior fossa.

Russell and Bucy[8] listed meningiomas of the posterior fossa as being a tenth as frequent as supratentorial meningiomas and stated that one of 10 tumors of the posterior fossa was a meningioma; these authors reported 15 cases of meningioma of the posterior fossa, in five of which the tumor was situated at the cerebellopontine angle.

Woltman and Love[9] emphasized that meningiomas may produce extremely few recognizable signs and symptoms even after reaching a huge size.

Bager[10] found meningiomas at the cerebellopontine angle to be only a fifteenth as common as acoustic neuromas of the same region.

Cushing and Eisenhardt reviewed seven cases of meningioma of the cerebellar chambers simulating acoustic neuroma and concluded, even after knowing the diagnosis, that the clinical findings were still sufficiently typical to justify a diagnosis of acoustic neuroma.

Brown and Love[11] found some degree of impairment of labyrinthine function in all of 79 cases of acoustic neuroma in which adequate tests were done. In Ireland's[12] series of acoustic neuromas, 4.3 per cent were found to be associated with normally functioning equilibrial labyrinths.

Dix and associates,[13] as well as Eby and Williams,[14] reported that recruitment of loudness was present in cochlear lesions and was absent in injuries to the trunk of the VIIIth nerve brought about by tumors at the cerebellopontine angle.

PRESENT STUDY.

This study represents an analysis of data in 55 cases of cerebellopontine meningioma in which operations were performed and the diagnoses confirmed microscopically. Seventeen patients were male and 38 were female. At the time of examination, the youngest patient was 12 years of age and the oldest 65. Three patients were less than 30 years of age and four were more than 60. Forty patients were between 40 and 60 years of age. No attempt was made to list the complete neurologic findings, the purpose being to examine the data from an otologist's viewpoint, to attempt to ascertain any signs or symptoms that might be helpful in the diagnosis of cerebellopontine meningioma, and to list findings in addition to those resulting from injury to the VIIIth cranial nerve that could be elicited with the equipment at hand and that, when found, suggested the presence of a lesion at the cerebellopontine angle.

This study is concerned primarily with meningiomas at the cerebellopontine angle; however, the difficulty of the differentiation of meningiomas from acoustic neuromas was made so apparent by a general review of tumors at the cerebellopontine angle that it appeared worth while to compare a series of these two types of tumors and list any findings that might aid in the differential diagnosis. Cysts, cholesteatomas, vascular anomalies, chemodectomas, neuromas of the Vth nerve and inflammatory lesions may produce similar findings, but only meningiomas and acoustic neuromas will be considered in this study.

SIGNS AND SYMPTOMS OF DECREASED FUNCTION OF THE VIIITH CRANIAL NERVE.

In the majority of instances, meningiomas at the cerebellopontine angle produce symptoms and signs readily recognized as due to a lesion in this region, even though the exact nature of the disease is not a certainty.

Evaluation of audiograms and the results of caloric tests, along with assessment of the proper significance of tinnitus and disturbed equilibrium, may aid in placing a given tumor

at the cerebellopontine angle and occasionally offer evidence that the lesion is a meningioma.

In studying a group of cases, the reviewer invariably regrets that in some instances the records are not more nearly complete; this is particularly true in neurologic patients, many of whom are too seriously ill to give complete co-operation. The hearing and caloric tests in this series were carried out by several persons, and the methods used were not always

Table 1.

SYMPTOMS OF DYSFUNCTION OF THE VIIITH NERVE IN 55 CASES OF MENINGIOMA AT THE CEREBELLOPONTINE ANGLE.

SYMPTOMS	Number	Per cent (of 55)
Loss of hearing	49	89
Total or severe loss of hearing on side of lesion	33	60
Moderate loss of hearing on side of lesion	10	18
Slight loss of hearing on side of lesion	6	11
Bilateral loss of hearing	15	27
Normal hearing	6	11
Loss of hearing as first symptom	30	55
Patients tested for recruitment	2	4
No recruitment present	2	4
Unilateral tinnitus	24	44
Bilateral tinnitus	5	9
Tinnitus as first symptom	5	9
Dizziness	22	40
Vertigo	6	11

the same. If the data obtained in a given instance did not appear reasonably accurate, the case was not included in the study.

Table 1 lists the symptoms of decreased function of the VIIIth cranial nerve in this series. For emphasis, it appears pertinent to dwell briefly on some of the more important findings. Deafness was present in 49 of these 55 cases of cerebellopontine meningioma (89 per cent). In 33 instances (60 per cent), the loss of hearing was severe or total on the side of the lesion; in 16 instances (29 per cent), the ipsilateral decrease in acuity of hearing was slight to moderate, and in six (11 per cent) of the cases, the hearing was normal

in both ears. Varying degrees of bilateral loss of hearing were present in 15 cases (27 per cent). In most cases of a bilateral decrease in auditory acuity, the contralateral deafness apparently was caused by presbycusis, chronic adhesive processes or other disease rather than by the meningioma.

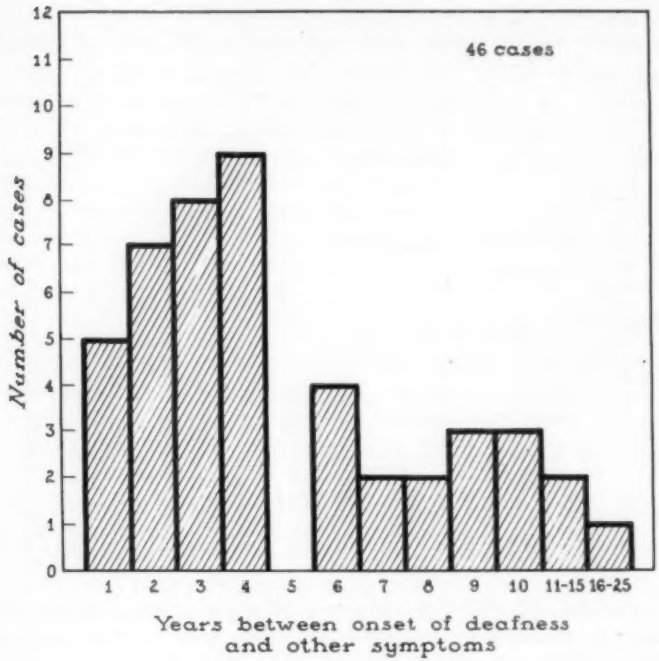

Fig. 1.

Frequency distribution of 46 cases of meningioma at the cerebellopontine angle by interval between onset of deafness and the appearance of other symptoms.

Deafness or tinnitus or both were the initial symptoms in 35 (64 per cent) of these 55 cases of cerebellopontine meningioma. Tinnitus was found in 29 (53 per cent) of the cases; it was bilateral in five instances. There was nothing diagnostic about the tinnitus, but it was frequently unusual in being intermittent. In one instance, it was present for a

number of years and then disappeared. A few patients noticed tinnitus only with flare-up of other symptoms, such as headache.

Recruitment was absent in the two patients who were tested for recruitment in the deafened ear over the normal ear.

The length of time between the onset of deafness and the appearance of other symptoms that ultimately brought about the diagnosis of meningioma at the cerebellopontine angle is shown in the accompanying figure. Of the 46 patients

Table 2.

RESULTS OF CALORIC TESTS IN 28 CASES OF MENINGIOMA AT THE CEREBELLOPONTINE ANGLE.

RESULTS	Number	Per cent (of 28)
Normal labyrinths, bilateral	5	18
Slightly hypoactive labyrinth on side of lesion	1	4
Moderately hypoactive labyrinth on side of lesion	1	4
Severely hypoactive or nonfunctioning labyrinth on side of lesion	19	68
Nonfunctioning labyrinths, bilateral	1	4
Moderately hypoactive labyrinths, bilateral	1	4

from whom reasonably accurate histories could be obtained, 29 noticed symptoms other than deafness within four years. Symptoms of VIIIth-nerve dysfunction alone were present for more than 10 years in three patients, one of whom noticed deafness for 25 years before symptoms suggesting intracranial disease appeared.

Caloric tests for evaluation of the function of the equilibrial labyrinths were carried out in 28 cases (see Table 2). Equilibrial labyrinthine function was normal in five (18 per cent) of these 28 cases. In most of the entire series, a pronounced loss of hearing was accompanied by a correspondingly severe decrease in equilibrial labyrinthine function; however, labyrinthine function was normal in two instances of severe deafness on the side of the meningioma, and only a slightly

damaged equilibrial labyrinth was found in one instance of extensive ipsilateral decrease in auditory function.

SIGNS AND SYMPTOMS SUGGESTING INTRACRANIAL ORIGIN OF VIIITH-NERVE DYSFUNCTION.

Detailed evaluation of signs and symptoms referable to the VIIIth cranial nerve is essential, but they must be accompanied by evidence of changes in the central nervous system in order to place the lesion at the cerebellopontine angle and to suggest that the tumor is a meningioma.

Table 3.

FINDINGS IN ADDITION TO DYSFUNCTION OF THE VIIITH NERVE IN 55 CASES OF MENINGIOMA AT THE CEREBELLOPONTINE ANGLE.

SIGNS OR SYMPTOMS	Number	Per cent (of 55)
Corneal anesthesia	40	73
Ipsilateral only	27	50
Contralateral only	1	2
Bilateral	12	22
Paresthesia	27	49
Face	19	35
Tongue	6	11
Extremities	6	11
Bilateral	4	7
Headache	32	58
Frontal	7	13
Occipital	13	24
Generalized	12	22
Facial weakness	15	27
Slight	10	18
Moderate	4	7
Complete	1	2
Bilateral	2	4
Spontaneous nystagmus	45	82
To right and left	40	73
Toward side of lesion only	3	5
Toward side opposite lesion only	2	4
Vertical component also	21	38
Facial pain	3	5
Trigeminal neuralgia	3	5
Visual disturbances	19	35
Choked disk	23	42
Disturbances in gait	39	71
Difficulty in swallowing or defects in speech	15	27
Weakness of pharyngeal muscles	6	11
Paralysis of vocal cord	3	5
Positive X-ray findings	15	27
Suggesting cerebellopontine-angle lesions	6	11
Suggesting increased intracranial pressure	9	16

Table 3 lists the symptoms and signs of involvement of the central nervous system which, taken in conjunction with those of decreased function of the VIIIth cranial nerve, indicated pathologic changes at the cerebellopontine angle. Spontaneous nystagmus was the commonest finding that, in addition to evidence of VIIIth-nerve dysfunction, suggested a lesion in the posterior fossa. This abnormality was found in 45 of the 55 patients (82 per cent). Three patients presented spontaneous nystagmus with the quick component toward the side of the lesion only; in two patients, the quick component was present only when the eyes were deviated toward the side opposite the meningioma. In the great majority of instances (40, or 89 per cent of the afore-mentioned 45 patients), the spontaneous nystagmus was present on lateral gaze both to the right and to the left; in 21 instances, a vertical component to the spontaneous excursions of the eyes also was present.

The spontaneous nystagmus associated with cerebellopontine meningiomas was more often coarser and slower toward the side of the lesion than toward the unaffected side. The quick and slow components of the nystagmus were not so clear-cut as in the usual labyrinthine nystagmus. Although in most instances they were not present when the patient was looking straight forward, the ocular excursions became wild and active on deviation of the eyes from the midline. The nystagmus of the two eyes was commonly in perfect rhythm and, although it was especially vigorous, it was easily reversed by caloric stimulation of the ear.

Corneal anesthesia was the second commonest additional finding suggestive of intracranial disease (40 instances, or 73 per cent). The decreased corneal sensitivity most often was on the side of the lesion only, but it was bilateral in 12 of 40 instances. The corneal anesthesia frequently was pronounced and easily demonstrated, but repeated examinations were necessary at times to establish the decreased sensitivity.

Headache was a common finding. Although considerable variation occurred in the location and type of this discomfort, it was often a major complaint and frequently caused the patient to seek medical assistance. The headache ordinarily

tended to increase in severity from the time of its onset and differed sufficiently from the usual type of cephalic pain to cause the clinician to seek accompanying findings suggestive of serious organic disease.

Twenty-seven (49 per cent) of the patients presented some type of paresthesia. The face or tongue was involved most frequently, and usually the sensation was constant and unilateral and progressed to involve adjacent regions strongly suggesting the organic nature of the complaint; however, this symptom was less definite in a few instances. One patient complained that numbness had been present in the ring finger of each hand for several months. A second patient had noticed a prickling sensation of the finger tips for one year. Another had experienced numbness of the left hand for 18 months, and the sensation gradually had extended to involve the ipsilateral side of the body and the ipsilateral leg and foot.

Fifteen patients presented some degree of facial weakness. In most instances, paresis was slight and evident only on close inspection. Bilateral involvement of the facial nerve was present in two patients.

Visual disturbances were frequent (19 patients, or 35 per cent). Failing vision, diplopia or blurring of vision were the usual complaints which, along with other findings, led to ophthalmoscopic evaluation and the finding of choked disks in 23 (42 per cent) of the patients.

As noted in Table 1, some type of dizziness was present in 22 instances (40 per cent) and most frequently was postural in nature. True spinning vertigo was found in six instances; in every case in which the vertigo possibly might be confused with labyrinthine imbalance, additional findings were present that pointed toward an intracranial origin of the vertigo. One patient complained of mild postural imbalance of six months' duration and on one occasion experienced violent spinning vertigo on lying down. The vertigo lasted only a few minutes, was not accompanied by nausea or otic symptoms and had been preceded by rapidly increasing occipital headaches. A second patient gave a history of two short attacks of subjective vertigo that were preceded by paresthesia of the face.

A third patient noticed that sudden turning to the right would produce a short attack of vertigo once or twice daily. She also had been conscious of numbness of the ipsilateral angle of the mouth for six years. A fourth patient had been subject for three years to sudden short attacks of vertigo not initiated by positional change. She invariably fell to the right side (opposite the lesion) and had injured herself several times. Burning of the ipsilateral side of the tongue was present before the onset of the attacks of vertigo, and she was frequently unconscious during these episodes. While playing volleyball, a fifth patient fell to the ground because of a violent attack of vertigo that lasted 15 minutes. He gave a history of increasingly severe headaches and on examination presented a central type of spontaneous nystagmus.

Helpful roentgenologic findings were present in 15 of the patients (27 per cent). Destruction of the sella turcica was present in seven instances, erosion of the tip of the petrous pyramid was evident in three, and the tumor had caused decalcification of the tip of the petrous pyramid in two instances. The posterior clinoid processes were eroded in two cases, and a large irregular calcified tumor in the posterior fossa with extensive secondary erosion from pressure of the sella turcica and the tip of the petrous pyramid was present in one case. The other findings in Table 3 do not call for further elaboration.

In order to complete the findings in this series of meningiomas at the cerebellopontine angle, it appears pertinent to present one case in some detail.

A 43-year-old woman had noticed the onset of right tinnitus and deafness eight years before reporting for examination. The deafness rapidly became severe. Nine months before she was examined, chills and fever had been present for one day. At this time she had noted a period lasting from five to ten minutes during which there was severe right frontal headache accompanied by visual hallucinations (spinning disks before the right eye only). Eight months before examination, the patient had discovered that she could touch a growth in her right ear with a hairpin. There had been no discharge from the ear. Examination disclosed a warty tumor almost completely occluding the right external auditory canal and complete right deafness. Further evaluation demonstrated bilateral choked disks and an eroded sella turcica. Biopsy of the mass in the external auditory canal established a diagnosis of meningioma.

COMMENT.

Table 4 presents a comparison of the symptoms and signs in these 55 cases of meningioma at the cerebellopontine angle with the symptoms and signs in 150 cases of unilateral acoustic neuroma that have been studied previously. Differential points shown in the table will be amplified.

Table 4.

RELATIVE FREQUENCY OF SYMPTOMS AND SIGNS IN MENINGIOMAS AT THE CEREBELLOPONTINE ANGLE AND IN ACOUSTIC NEUROMAS.

	Cerebellopontine-angle meningioma (55 cases)		Acoustic neuroma (150 cases)	
SYMPTOMS	Number	Per cent	Number	Per cent
Loss of hearing or tinnitus as first symptom	35	64	105	70
Severe or total loss of hearing on side of lesion	33	60	114	76
Moderate loss of hearing on side of lesion	10	18	19	13
Slight loss of hearing on side of lesion	6	11	2	1
Normal hearing	6	11	0	0
Tinnitus	29	53	100	67
Vertigo	6	11	16	11
Dizziness	22	40	53	35
Corneal anesthesia	40	73	126	84
Ipsilateral only	27	50	110	73
Bilateral	12	22	16	11
Paresthesia	27	49	77	51
Headache	32	58	105	70
Facial weakness	15	27	55	37
Slight to moderate	14	25	9	6
Complete	1	2	1	1
Spontaneous nystagmus	45	82	125	83
Choked disk	23	42	74	49
Facial pain	3	5	16	11
Trigeminal neuralgia	3	5	0	0
Visual disturbances	19	35	47	31
Positive x-ray findings	15	27	64	43
Positive Romberg	39	71	106	71

Meningiomas are slow-growing vascular tumors that choose certain special regions of the meninges as their point of origin and exert their harmful influence by the production of gradually increasing pressure on the surrounding intracranial structures as well as the contiguous calvarium or the base of the skull. These tumors almost never metastasize

and, as already mentioned, may attain great size before they produce recognizable clinical symptoms.

The cerebellopontine angle is one of the favorite points of origin for meningiomas. Here the crowded structures of the brain stem and its attached cranial nerves, together with the cerebellum, are gradually pushed aside and distorted until their functional parts are sufficiently damaged to result in increased intracranial pressure, signs and symptoms of changes in the cranial nerves, and cerebellar incoordination. As the tumor encroaches on the petrous portion of the temporal bone, decalcification or bony destruction is brought about. If there is extensive involvement of the temporal bone, the tumor may reach the middle ear or the external auditory canal and be evident on direct inspection.

The VIIIth cranial nerve appears to be particularly prone to injury by tumors originating at the cerebellopontine angle, and meningiomas found in this region are no exception. Loss of hearing, tinnitus and disturbed equilibrium are usually present, are commonly prominent and, in the early stages, may be the only symptoms that lead the patient to consult his physician. The neural type of loss of hearing found in meningiomas at the cerebellopontine angle most commonly progresses rapidly to severe or total lack of cochlear function. In this series, 33 patients (60 per cent) presented insufficient remaining hearing at the time of their initial examination to be suitable subjects for audiographic study and special tests of hearing; however, only slight to moderate deafness was found in 16 instances (29 per cent). It is in this latter group of patients, who have considerable residual hearing, that the diagnosis is likely to be obscure and that tests for recruitment are of value in differentiating the end-organ type of nerve deafness from hearing loss due to injury to nerve fibers at the cerebellopontine angle. As noted previously, tests for recruitment were done on two patients with meningiomas at the cerebellopontine angle and recruitment was absent in both.

Six of these 55 patients demonstrated that normal hearing in the presence of a lesion obviously situated at the cerebellopontine angle does not necessarily rule out menin-

gioma. Loss of hearing or tinnitus is the commonest initial symptom produced by meningiomas of the cerebellopontine angle, the incidence being 64 per cent in this series. Commonly, additional findings soon indicate the deafness to be of intracranial origin. Twenty-nine of 46 patients in this series noticed symptoms other than deafness within four years. Infrequently, however, deafness or tinnitus may be the only symptom for many years, as demonstrated by the afore-mentioned patient who had impaired hearing, as well as tinnitus, for 25 years before the appearance of additional symptoms suggesting pathologic changes at the cerebellopontine angle. A meningioma at the cerebellopontine angle is a possibility in any instance of unexplained nerve deafness, particularly if the loss of hearing is unilateral and rapidly progressive. More serious consideration must be given to this lesion if recruitment is absent and there are additional findings suggesting pathologic changes in the posterior fossa.

Varying degrees of equilibrial disturbance are common in meningiomas at the cerebellopontine angle; however, such a lesion is an extremely remote possibility if true spinning vertigo is present and there are no additional symptoms, such as paresthesia, spontaneous nystagmus, visual disturbances or unusual types of headache.

Normal audiograms and normal results of caloric tests do not rule out meningioma at the cerebellopontine angle. Evaluation of decreased cochlear and labyrinthine function, when considered in conjunction with additional signs and symptoms, may suggest the correct diagnosis. A careful history is essential, and particular inquiry should be made regarding equilibrial disturbances, headaches, paresthesia, diplopia, blurred or failing vision, facial pain, difficulty in swallowing, defects in speech and hoarseness.

Roentgenograms of the head may indicate local changes due to pressure on contiguous bony structures, evidence of increased intracranial pressure, or a calcified tumor suggestive of meningioma.

Examination of the ocular fundi is always important in unexplained nerve deafness, as choked disks suggest an intracranial origin of the loss of hearing.

Search for evidence of involvement of cranial nerves is extremely important in suspected meningioma at the cerebellopontine angle. Involvement of the Vth nerve, with corneal anesthesia or decreased sensation over the face, is a frequent finding. Facial weakness on the side of the lesion may be present, although it is seldom pronounced and only occasionally complete.

Paralysis of the palate or the constrictor muscles of the pharynx, deviation of the tongue, and nonfunction of the ipsilateral vocal cord may be present, being noted most commonly in far-advanced meningiomas at the cerebellopontine angle.

Findings indicative of involvement of cranial nerves are usually noted on the same side as the meningioma but, due to torsion of the brain stem or direct pressure from the tumor, these findings occasionally may appear on the side opposite the lesion.

Examination of Table 4 demonstrates that the signs and symptoms of meningiomas at the cerebellopontine angle are similar to those of acoustic neuromas originating in the same region. In many instances, it is impossible to differentiate preoperatively between these two lesions.

Since acoustic neuromas at the cerebellopontine angle are so much commoner than are meningiomas, a tumor in this region must be considered to be a neuroma until certain atypical features, such as the following, suggest the presence of a meningioma:

1. Labyrinthine function almost always is impaired or completely abolished in acoustic neuromas, whereas it is normal in a small percentage of meningiomas at the cerebellopontine angle.

2. Meningioma is a more likely possibility than is acoustic neuroma in the presence of normal hearing and a tumor that is obviously situated at the cerebellopontine angle.

3. Meningioma is to be considered as a possibility in any instance of a tumor at the cerebellopontine angle with slight to moderate loss of hearing.

4. With severely depressed hearing and normal or slightly decreased labyrinthine function, meningioma is more probable than is acoustic neuroma.

5. Meningioma is the more probable diagnosis if trigeminal neuralgia is one of the findings associated with a tumor at the cerebellopontine angle.

6. Roentgenographic examination may show enlargement of the internal auditory meatus, which suggests acoustic neuroma, or it may disclose a calcified tumor or changes in the surrounding skull, findings that are characteristic of meningioma.

7. The tumor occasionally may be present in the external auditory canal or middle ear and the differential diagnosis may be made by microscopic examination of tissue.

SUMMARY AND CONCLUSIONS.

A review was made of 55 cases of meningioma at the cerebellopontine angle in which operations were performed and in which the diagnoses were confirmed by microscopic examination of tissue. An attempt was made to list signs and symptoms that, when found in addition to evidence of impaired function of the VIIIth cranial nerve, were suggestive of a lesion at the cerebellopontine angle. An attempt also was made to determine whether there were any signs or symptoms peculiar to meningiomas at the cerebellopontine angle that might tend to allow differentiation of this lesion from the commoner acoustic neurofibroma.

On the basis of this study, the following conclusions are made:

1. Meningiomas, while not common, are of sufficient frequency to be considered in the differential diagnosis of most lesions obviously situated at the cerebellopontine angle.

2. Signs and symptoms indicating disturbed function of the VIIIth cranial nerve usually are prominent and early in meningiomas at the cerebellopontine angle, and detailed evaluation of hearing and of equilibrial labyrinthine function is valuable in reaching the proper diagnosis.

3. Evaluation of the function of the VIIIth cranial nerve may suggest a lesion at the cerebellopontine angle, but the findings must be linked with signs and symptoms of intracranial pathologic changes before the diagnosis of a tumor in this region can be established.

4. Preoperative differentiation of meningioma and acoustic neuroma is impossible in many instances, but at times the otologist can offer substantial assistance in the distinction between these two lesions.

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THE TRIAD OF KARTAGENER. RELATION OF UPPER TO LOWER RESPIRATORY PATHOLOGY.

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I. INTRODUCTION.

The intimate relationship between the disease of the upper and lower respiratory airways has become more and more evident in recent years through radiological and bronchographic studies and a more careful evaluation of the patients with respiratory symptomatology.

It is not unusual for the chest physician in the diagnosis and therapy of pulmonary diseases to be confronted with symptoms such as cough, hemoptysis, expectoration, dyspnea and wheeze whose origin relates to pathologic conditions of the upper respiratory passages. On the other hand, the otolaryngologist treats conditions of the nose and throat that have their origin in the lungs.

Cracovaner[1] has recently analyzed the principal symptoms of pulmonary disease related to nose and throat pathology. Cough, in particular, may be reflex from areas in the nose due to irritation from mucus, congestion or fumes, enlarged turbinates, or from contact due to a deviated septum. Infections, nasal allergy and vasomotor disturbances play an important role in this reflex.

In children, infection of the tonsils and adenoids may predispose to exacerbations of cough. The cough that accompanies

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a recurrent naso-pharyngeal condition or persists after an upper respiratory infection is frequently associated with an allergic state: sensitivity to bacteria in the excessive lymphoid tissue. This condition may account for the asthmatic component of infections and allergic conditions of the nose and paranasal sinuses.

The anatomical consideration that the mucous membrane of the upper respiratory tract is continuous with that of the trachea and bronchi explains how readily an infective process can be transmitted from one segment to another. On a physiopathologic basis the upper respiratory tract influences the lower respiratory system as an air conditioner of the inspired air, originating naso-broncho-pulmonary reflexes, as a source of germs for the lower tract and initiating phenomena of hypersensibility in the respiratory system. Similarly, a pathologic condition of the tracheo-bronchial tree may influence the nose and paranasal cavities.

Clinically, the relationship between sinusitis and pulmonary conditions, particularly bronchitis and bronchiectasis, is of prime importance.

Price[2] studied the frequency of sino-bronchitis among infants and children with symptoms of chronic respiratory tract infection and among those with no respiratory symptomatology. Allergy seems to be an important factor in childhood sino-bronchitis. Roche[3] studied the etiology and pathogenesis of rhino-bronchorrhea and bronchiectasis in infancy. On the other hand, there are descriptions of sinus infection in children that fail to recognize the frequent association of sinusitis and broncho-pulmonary disease.

Mounier-Kuhn[4] described in children the syndrome "ethmoidoantritis and bronchiectasis" as manifest at the highest and lowest level of an affection involving the entire respiratory system. An allergic background seems to be present in most of these patients.

These observations pose the problem of the pathogenesis of bronchiectasis as congenital or acquired, primary or secondary to the upper respiratory condition, which has been discussed from a clinical point of view, but seldom on a pathologic basis.

In 1933, Kartagener[5] correlated etiologically a congenital anomaly to the disorders of the upper and lower air passages and described a syndrome consisting of complete transposition of the viscera, bronchiectasis and chronic rhino-sinusitis. The usual findings in the upper respiratory tract are nasal polyposis, chronic hyperplastic rhinitis, ethmoido-maxillary sinusitis and absence or underdevelopment of the frontal sinuses.

A review of the literature revealed that more than 100 cases of Kartagener's syndrome have been reported; however, not all of the cases show an undisputable radiological evidence of bronchiectasis and a complete *situs inversus*. For this reason, Dickey[6] has recently suggested to substitute dextrocardia for complete transposition of viscera.

The clinical, radiological and pathological study of two cases of Kartagener's syndrome prompted the evaluation of the relationship between the several items of this syndrome, particularly between upper and lower respiratory pathology.

II. CASE REPORTS.

Case 1: M. L. B., 19-year-old white male was seen in the ENT Clinic, Research and Educational Hospitals of the University of Illinois because of a persistent cough, drainage from the nose and absence of the sense of smell. The past history revealed a chronic cough, productive of a thick, yellowish sputum, as long as he could remember; however, it had been only since three years before, at which time the patient fell into a ditch, that the cough became troublesome and more productive, and at present about one cup of this thick, yellow foul smelling sputum is brought up daily. His nose has been discharging as long as the patient can recall; first of a thin colorless, watery type and subsequently of a thick, purulent nature. He had never known a sense of smell, though the odor of his discharge had been described to him as bad. Nasal polyps had been removed in the past, but without any result. Family history was noncontributory.

Physical examination revealed a well-developed white male, apparently not acutely ill. There was a fusiform swelling of the joints of both hands and feet interpreted as rheumatoid arthritis. Examination of the chest and abdomen revealed a complete transposition of the viscera. Hypoventilation was noted in the right plumonary field, while moist rales were heard in the left lower segment of the lung.

The otolaryngological examination revealed a considerable amount of muco-purulent secretion in both middle meatuses, nasal floor, nasopharynx and posterior wall of the oropharynx. Both inferior turbinates were quite large and polypoid in appearance. The tympanic membranes were opaque, dull and lusterless, but without any evidence of perforation or scar. The larynx was essentially normal. The transillumination revealed darkness of all the sinuses. An irrigation of both antra through the natural ostia revealed a considerable amount of foul, purulent discharge.

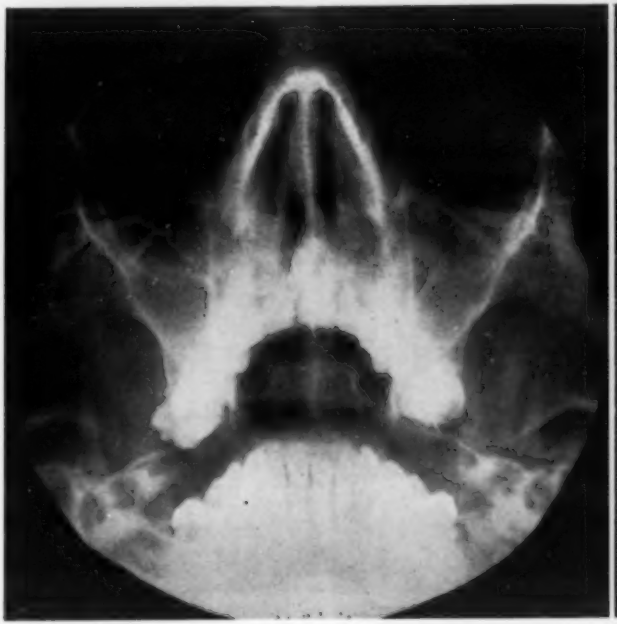

Fig. 1. Routine Waters' projection revealed diffuse clouding of both antral sinuses. This was a part of a pansinusitis.

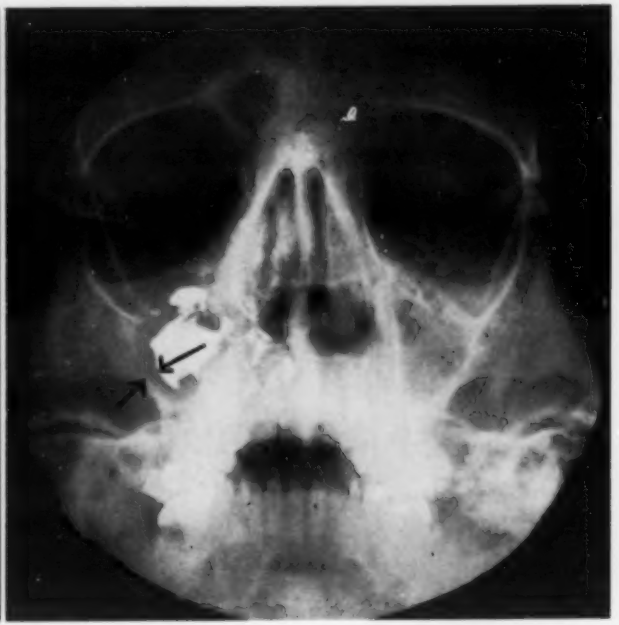

Fig. 2. Right antral sinogram reveals irregularity and deformity of the sinus cavity by thickened hyperplastic mucosa. Note the space between the lateral margin of the opaque material and the lateral bony wall of the antrum.

The X-rays of the sinuses showed the frontal sinuses to be poorly developed and cloudy; their walls lacked the usual sharp white cortical line (see Fig. 1). There was diffuse clouding of both antral and sphenoid sinuses and partial opacification of the ethmoid cells, indicating pansinusitis.

A right antral sinogram showed the deformity of the contrast material due to hyperplastic antral mucosa (see Fig. 2). From the appearance of the plain films there is reason to believe that a similar condition is present on the left side.

The X-rays of the temporal bones revealed normal development and pneumatization of the mastoid processes.

In the chest X-ray the cardiovascular shadow was noted to be reversed—the apical region appearing prominent on the right side instead of the left, as in the usual orientation. This is a part of a complete *situs inversus*. The plain chest film further revealed increased radiolucency in the right lower lung field compatible with emphysema. An oblique density is seen through the heart shadow and may represent an atelectatic lower lobe. A diffuse reticulated increased density, suggesting honey-combing, was noted in the left lower lung field. These changes are probably all secondary to bronchiectasis (see Fig. 3).

The upper and lower gastro-intestinal study revealed all the viscera to be completely reversed, establishing the presence of a complete *situs inversus*.

The X-rays of the limb joints revealed normal feet, shoulders and elbows. Soft tissue swelling about the middle interphalangeal joints with equivocal cystic changes in the periarticulatory surfaces were interpreted as early rheumatoid arthritic changes.

A thorough laboratory work-up was done. The standard electro-cardiogram revealed typical "mirror image" tracing of dextrocardia. Urinalysis was normal. Serology was negative. Complete blood count showed a white count of 11,450, otherwise normal. Blood chemistry was within normal limits. Sedimentation rate (Wintrobe corrected) was 28 mm. per hour. Sputa were negative for acid fast bacilli, but positive for Neisseria catarrhalis, alpha streptococci and Friedlander's bacillus.

The allergy consultation reported history of nasal polypectomy, but no history of sensitivity to food, drug, vegetation, dust or animals, and no previous apparent allergic trouble. Intracutaneous tests to all the available exogenous allergens were negative. Treatment with antihistamins gave no result.

The bronchoscopy showed the mucosa of the tracheo-bronchial tree to be moderately hyperemic and edematous. A profuse amount of milky secretions gushed forth from all the orifices. It appeared that the main bronchi were reversed in position.

The bacteriological report of bronchial secretions revealed Neisseria catarrhalis, alpha streptococci, hemophilus influenzae and diphtheroids.

The bronchogram revealed the lungs to be transported, since an upper, middle and lower lobe bronchial branch was demonstrated on the patient's left side and an upper including lingula and lower lobe branch was outlined on the patient's right side.

Tubular dilatations of the lower lobe bronchial tree on the left supported the plain film impression of left lower lobe bronchiectasis (see Fig. 4). Other films, not shown, demonstrated that the right lower lobe bronchial tree could not be visualized beyond approximately a 3 cm. stump, again supporting the probability of right lower lobe collapse and compensatory emphysema of the upper lobe.

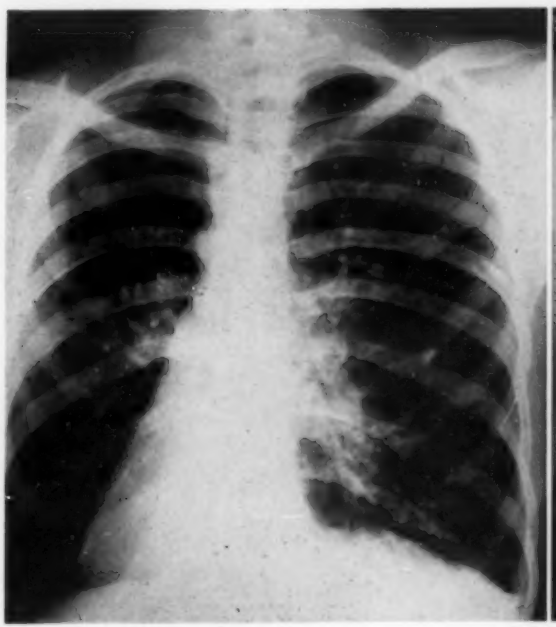

Fig. 3. Chest: Note the reversed orientation of the cardiovascular structures. This was part of a complete situs inversus; also note the irregular increased markings above the left diaphragm and extending into the left hilar and perihilar area. The pulmonary changes are bronchiectatic in nature.

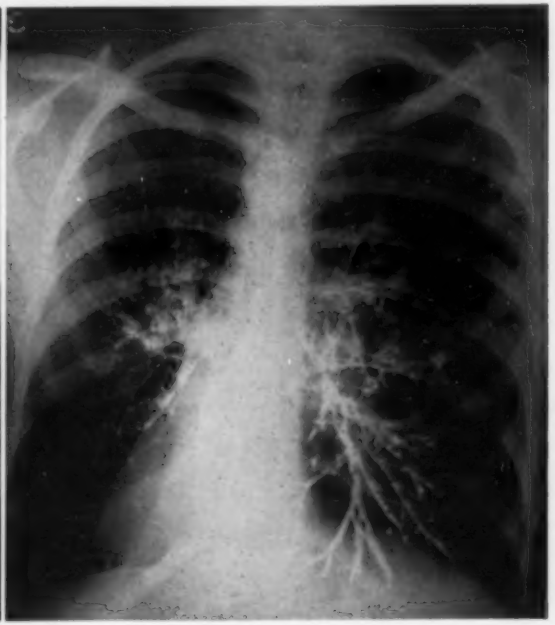

Fig. 4.. Bronchogram. Note the tubular dilatation of the lowermost bronchi representing bronchiectasis.

A right lower lobectomy was, therefore, decided upon. At surgery the right upper lobe was enormous, while the lower was a small shrunken atelectatic dark colored structure, which lay far posteriorly.

The pathologic diagnosis was bronchiectasis of the right (left) lower lobe with bronchostenosis. Microscopically, the sections through the lung showed dilated bronchi, lined by ciliated columnar epithelium. The bronchi were surrounded by an increased amount of fibrous tissue and areas of focal and diffuse lymphocytic infiltration. The cystic lumina were filled with acidophilic material and mononuclear cells. Some of these cells were large; there was also multinucleated giant cells. Adjacent lung parenchyma showed the alveoli to be filled with red blood cells, mono- and polymorphonuclear cells. There were areas where the alveoli were collapsed. The trabeculae appeared to be thickened and showed an increased amount of fibrous tissue.

A naso-antral window was performed bilaterally at a later date to improve sinus drainage. Marked relief of cough and nasal discharge followed these two surgical procedures; however, sputum, though reduced considerably, did not clear up completely. Repeated Proetz displacements turned out to be quite useful to facilitate his sinus drainage.

Case 2: D. D., 39-year-old colored female, came to the ENT Clinic of the Research and Educational Hospitals of the University of Illinois because she had had "a cold in her head and chest all her life." She used two large boxes of tissues per week to blow her nose, which produced white to yellow discharge. She could not smell because of her trouble. Her past history revealed that she had productive cough and excessive nasal discharge ever since she could remember. She had been coughing day and night; sputum was thick, yellow or greenish and approximately one cupful a day. No hemoptysis nor chest pain. Nasal discharge was excessive and there was stuffiness in her nose. No epistaxis nor headache. She had lost 13 pounds in ten months.

Tonsillectomy and adenoidectomy was done in childhood. She had some treatment for her sinuses, and antrostomies were performed a few years earlier on both sides.

Family history revealed that her father died 18 years before of tuberculosis. Her brother has been treated all his life for bronchiectasis and sinusitis, but has no transposition of viscera.

Physical examination revealed a well-developed, moderately nourished colored female with a mild finger clubbing. Complete transposition of the viscera was noted on examining the chest and abdomen. Moist rales were heard in both lower pulmonary fields.

The otolaryngological examination revealed muco-pus in both middle meatuses, nasal floors and naso-pharynx. The middle and lower turbinates appeared very large and lined by a boggy and pale mucosa. The tympanic membranes were dull and lusterless, with no sign of perforation or healed perforation. The larynx was normal. The transillumination revealed opacity of all the sinuses.

The X-rays of the sinuses revealed the frontals to be undeveloped. There was clouding of the left antrum, and membrane thickening of the right antrum (see Fig. 5). The ethmoid and sphenoid sinuses appeared involved, too. These findings indicate pansinusitis. A left antral sinusogram confirmed the evidence of membrane thickening and antral sinusitis (see Fig. 6). The X-rays of the mastoids showed normal pneumatization of these processes.

The plain films of the chest revealed *situs inversus* and diffuse mottled increased densities in the left lower lung field. There was a suggestion of "honey-combing," indicating that this is a diffuse inflammatory

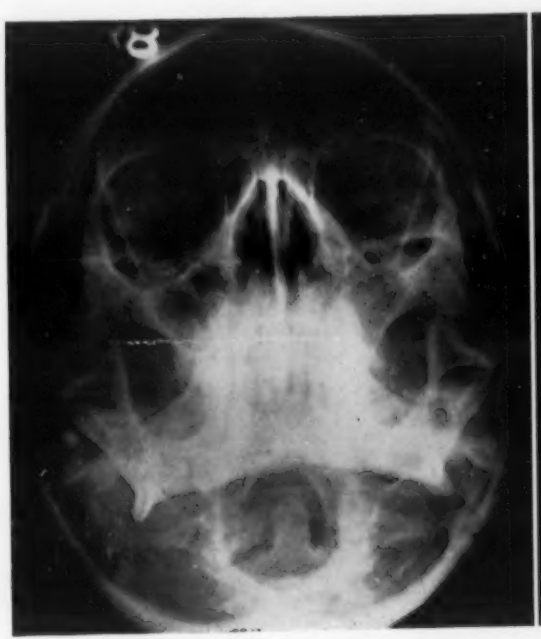

Fig. 5. Sinus examination, Waters' View. Note the diffuse clouding of the left antral sinus plus the membrane thickening in the right antral sinus secondary to sinusitis.

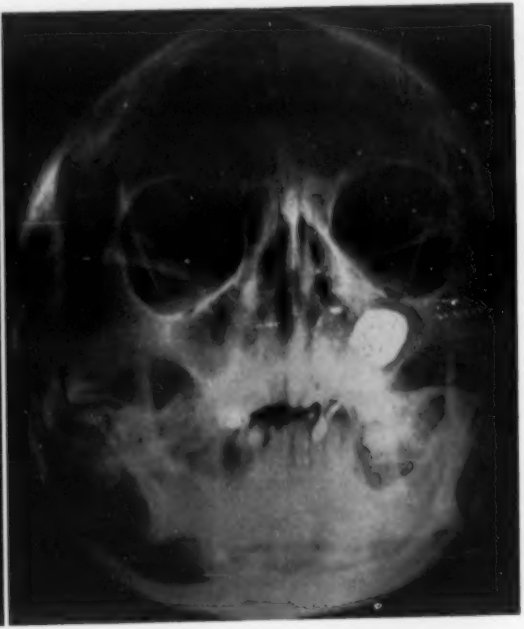

Fig. 6. Sinogram of left antrum. Note the globular appearance of the contrast material within the sinus associated with mucosal thickening.

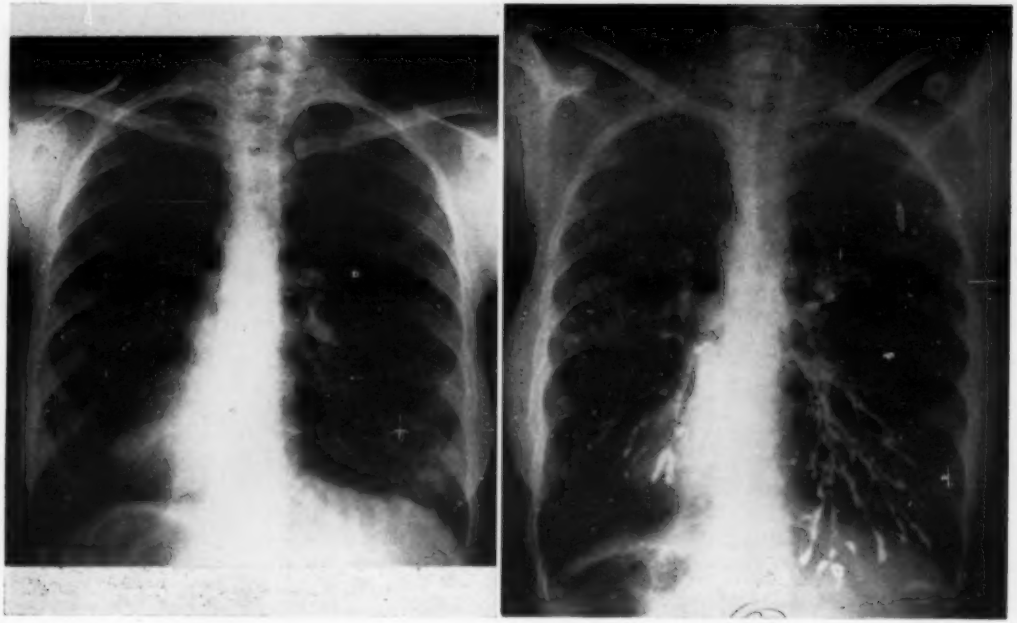

Fig. 7. Chest. Note the dextrocardia and right-sided position of stomach, a part of the patient's complete situs inversus. Also note the irregular mottled appearance of the lower lung field, the left in particular. These were due to bronchiectasis.

Fig. 8. Bronchogram. Note the bilateral cylindrical and saccular changes in the lower bronchial tree secondary to bronchiectasis.

process with possible underlying or superimposed bronchiectasis. These changes extended well into the base of the left lung. The right lower lung field contained numerous areas of increased radiolucency between the normal pulmonary markings. The basilar area looked emphysematous, probably bulbous or bleb formation. An oblique line seen through the heart shadow and extending roughly to the spine suggested partial collapse of the right lower lobe (see Fig. 7).

The upper and lower gastro-intestinal study confirmed the presence of a complete *situs inversus;* otherwise it appeared normal.

The reports of the laboratory work-up confirmed the diagnosis. The standard electrocardiogram showed the typical tracing of dextrocardia. Urinalysis was normal; serology was negative. Complete blood count was normal, except for a slight increase in the white cells. Blood chemistry was within normal limits. Sedimentation rate (Wintrobe corrected) was 38 mm. per hour. Sputum was negative for acid fast bacilli, but showed Neisseria, alpha streptococci, hemophilus influenzae.

An allergy survey with intracutaneous tests failed to reveal any allergic etiology of her respiratory symptomatology.

A bronchoscopy revealed both main bronchi to be filled with copious, thick, tenacious muco-pus. Hyperemia involved all tracheobronchial tree. The disposition of the bronchi confirmed the *situs inversus.* Impression was that of severe bilateral bronchiectasis involving chiefly the basilar segments. The bronchial culture revealed many hemophilus influenzae, a few Neisseria and alpha streptococci.

A bronchogram confirmed the presence of bilateral tubular and cystic bronchiectasis involving the entire lower lobe on both sides, with probable collapse of the dorsal basal segment of the patient's right. The lingula on the right side was also involved (see Fig. 8).

Due to the extensive involvement of the lungs, surgical treatment was not deemed advisable. Proetz irrigations resulted in relief of her sinus drainage. Acute flare-ups of the condition were adequately controlled with antibiotics and inhalations.

III. PATHOGENESIS OF KARTAGENER'S TRIAD.

Various views on the nature of the relationship between the items of Kartagener's syndrome have been advanced by several authors.

The transposition of viscera is a rare congenital anomaly characterized by a disturbance in the bilateral symmetry of the body. Its occurrence is about 1 to 10,000 (Kartagener,[5] Adams and Churchill,[7] Torgersen,[8] Pavlitzek[9]) among the general population.

According to the law of multiple anomalies, several other congenital anomalies have been reported with *situs inversus.* In particular, cases of Kartagener's triad have been described with an anomalous left subclavian artery,[10] malformations of the retinal vessels,[11] renal anomalies,[12] cardiovascular defect,[6,13]

turricephaly,[14] absence of the xiphoid process.[15] Multiple cases of Kartagener's triad in the same family and among twins have been reported by several authors.[6,8,10,16,17,18] According to Cockayne[19] the transposition of viscera is dependent upon a single autosomal recessive gene, while Torgersen[8] maintains that it may occasionally be inherited as a dominant character, occasionally as a recessive one and sometimes not at all hereditary.

Relationship Between Situs Inversus and Bronchiectasis.

This problem has been the object of discussion and many observations. Some authors favor the congenital theory of origin of bronchiectasis as contrasted to the theory that bronchiectasis is acquired.

Siewert[20] in 1904 was probably the first to speculate on the congenital etiology of bronchiectasis associated with *situs inversus*. The description of Kartagener's syndrome and following reports of this interesting association have further supported this theory.

According to Conway[21] the frequency of bronchiectasis among cases with *situs inversus totalis* is so much greater than in the general population as to suggest that the bronchiectasis may not be fortuitous, but due to a developmental error. The values vary between 16.5 and 25 per cent in complete *situs inversus* in contrast with 0.25 to 0.5 among all patients, according to Kartagener,[5] Adams and Churchill,[7] Olsen[22] and Gross.[23]

Richards[24] reported a case of Kartagener's triad with respiratory symptoms since the age of three days. In the case of Blixenkrone-Moeller[25], respiratory symptoms had been present since birth.

The histological study of specimens from lobectomy revealed in Ingraham's[26] case "persistence of peribronchial connective tissue and underdevelopment of alveolar structures," and in the case of Blixenkrone-Moeller[25] "very high cylindric epithelium in the abnormally wide bronchi and large accumulation of lymphoid tissue in the bronchial walls which suggest a congenital condition".

In an analysis of the pathogenesis of bronchiectasis, Sebesteny[27] considers three factors, the development of the lung, functional disturbances of the bronchial system and infection. Recent studies have shown that the development of the lung by differentiation, budding and expansions of pulmonary anlages continues after birth for approximately seven years. Defective postnatal lung development has been observed in early life associated with metabolic, endocrine, reticulo-endothelial and connective tissue disturbances. Bronchiectasis may develop in those pulmonary segments that remain in their fetal collapsed state and do not expand after birth. In fact, alveoli do not form in the atelectatic segments, and the corresponding bronchi, unsupported externally by aerated alveoli, may dilate as a result of the atmospheric pressure. The mucus secreted may become infected and contribute to the bronchial weakening and dilatation.

It is conceivable on the other hand that atelectasis may develop in a lobe previously normal with resultant bronchiectasis. The study of a large series of X-ray films has shown that collapse of a lobe or a segment of a lobe is quite frequent in lower respiratory infections, and that there is a tendency for dilatations of the bronchi and bronchioles supplying the atelectatic area. Failure of these bronchi to return to normal when atelectasis supersedes accounts for the development of bronchiectasis. It is at this moment that the local factors act to determine the persistence of dilatation of the bronchi. In both of our cases, lobar or segmental collapse was associated with bronchiectasis of a non-congenital type.

It seems, therefore, that a developmental mishap in the bronchi may account for some of the so-called "congenital bronchiectasis", but it is more probable that a congenital factor, evident in Kartagener's triad, predisposes the neonate with *situs inversus* either to defective postnatal lung growth or to atelectasis, and consequently the development of bronchiectasis. The same constitutional factor could represent the predisposition for the development and persistence of chronic sinusitis.

Radiographically the appearance of bronchiectasis in Kartagener's syndrome is generally tubular or varicose rather

than cystic, which are usually congenital. In one of our cases the bronchiectasis appeared typically cylindrical while in the other both fusiform and saccular dilatations were seen.

Most authors agree that pulmonary histological findings fail to show a definite evidence of congenital origin for bronchiectasis.[6,17,21,28] The histopathological study of the specimen from lobectomy in one of our patients did not reveal any structural alteration that could definitely be interpreted as congenital. Taiana et al.[29] recently reported that no difference could be observed in their specimen, from common bronchiectasis of the acquired type.

Relationship Between Transposition of Viscera and Upper Respiratory Tract Abnormalities.

The triad, as described by Kartagener, includes nasal polyposis and paranasal sinusitis, but Olsen[22] described four cases of dextrocardia and bronchiectasis without sinusitis and four further cases of dextrocardia and nasal sinusitis without bronchiectasis. According to Gross[23] sinusitis is not an essential item of Kartagener's syndrome, because of its sequential relationship with bronchiectasis.

The presence of nasal polyps or chronic hyperplastic rhinitis in cases of Kartagener's syndrome has been frequently reported. Torgersen[8] described five cases of *situs inversus* associated with nasal polyps without bronchiectasis. Among the cases presented in this paper, one had the history of nasal polypectomy and showed polypoid degeneration of the inferior turbinates, while in the other there was a picture of chronic hyperplastic rhinitis. The hyperplasia of the antral mucosa is demonstrated in the sinusograms. An allergic basis for this condition has been suggested; however, an allergy survey with cutaneous tests to all the available allergens failed to reveal any sensitivity. Sensitization to the allergens in the bacteria may be responsible for the respiratory infections. Blixenkrone-Moeller[25] tried to support this view, demonstrating allergic lung infiltrations in his case of Kartagener's triad.

It may be significant to note that our patient with the history of nasal polypectomy suffered from rheumatoid arthritis

and the same condition presented in the patient reported by Zuckerman and Wurtzerbach.[20]

Banham,[21] in his case of Kartagener's syndrome, reported complete absence of frontal and sphenoid sinuses and mastoid air cells and antra. Maxillary sinuses, as well as the few ethmoidal cells, were small. Both tympanic membranes were hanging in loose folds. The picture was interpreted as an arrest of development and pneumatization of the temporal bone at birth. Both our cases showed poor development of the frontal sinuses, bilateral pansinusitis and normal pneumatization of the mastoid processes.

Torgersen[8] in a comparative study of the size of the frontal sinuses in Kartagener's triad, *situs inversus* without bronchiectasis and in bronchiectasis in the normal *situs* found intermediate values for the last condition, the smallest values in Kartagener's triad and average size in *situs inversus* without bronchiectasis. Mounier-Kuhn[4] and Negri,[15] in cases of bronchiectasis in normal *situs* associated with sinusitis, reported a higher incidence of agenesis of the frontal sinuses than among the general population.

These observations tend to exclude a relationship between *situs inversus* and developmental anomalies of the frontal sinuses; rather the development of the frontal sinuses appears to be related to the disturbance in the respiratory system. Similarly, it seems improbable that in Kartagener's syndrome there is a congenital liability to sinusitis and that the bronchiectasis are secondary to it. It appears more probable that an allergic constitution might affect the whole respiratory tract.

Relationship Between Sinusitis and Bronchiectasis.

The sinus-chest relationship has been considered on an exogenous basis, especially for acquired bronchiectasis. In other words, bronchiectasis may be preceded by bronchitis or peribronchitis as a consequence of sinusitis. Aspiration and lymph stream have been considered the most likely routes of infection. On the other hand, bronchiectasis may precede sinusitis, and the infection may be transmitted to the upper respiratory segments by coughing. Finally, the same generalized inflam-

matory process may involve simultaneously both divisions of the respiratory tract.

Brock[32] maintains that sinusitis may be the primary or predominant lesion between sinusitis and a superficial, transitory condition such as bronchitis; however, when morbid anatomical changes develop as in bronchiectasis one must look for a local determining cause or factor either acquired or congenital. A high incidence of sinusitis in bronchiectasis has been reported clinically, while it seems quite uncommon to see bronchiectasis arise from chronic sinusitis. It has been demonstrated radiologically with contrast media that bronchiectasis is significantly related to sinus infection, probably due to intermittent or continuous production of purulent sputum, partially expelled through the upper respiratory airways. The expired air currents, as demonstrated by Proetz, pass beneath the middle turbinates coming in close contact with the sinus ostia.

The knowledge that sinusitis can cause acute, recurrent or chronic lower respiratory infection will explain how sinus infection may maintain and aggravate infections in the bronchiectatic lung. In this way upper and lower processes work together in the persistence of a diffuse respiratory infection. These considerations are of utmost importance in the management of these cases.

An endogenous basis has also been considered for the sinus-pulmonary relationship, and in particular for the development of bronchiectasis in children and in cases of Kartagener's syndrome.

Torgersen[8] in a series of studies on the genetics of Kartagener's triad indicated that "the lung-nose syndrome is inherited as a dominant trait, *situs inversus* behaving as a manifestation of a pleiotropic effect of this gene". In other words, there is a constitutional interrelation between nasal polyps and bronchiectasis, which is hereditary with a varying probability and mode of manifestation connected with the tendency to *situs inversus*.

It is possible that allergy which is inherited as a dominant trait represents the constitutional basis for the development of

bronchial and sinus conditions. The mechanical factor appears to be the most important in producing bronchial dilatations, and Davison[33] maintains that allergy, through the production of viscid secretion and narrowing of the bronchial lumen due to edema, may determine all the factors necessary for the development of bronchiectasis in children; and allergy, according to general clinical experience, is considered an underlying factor in the onset of nasal polyps and hyperplastic sinusitis.

Van de Calseyde[34] stresses the synchronism between the hyperplastic sinus pathology and bronchopulmonary disorders. Hypertrophic sinus affection means weakness or disharmony of the normal function and defense mechanisms of the whole respiratory system. Both sinus pathology and bronchiectasis would depend on the same constitutional cause, their reaction to disease varying according to their anatomical characteristics.

In this instance, sinusography appears just as useful in the differential diagnosis of the type of sinusopathy as bronchography in establishing the presence of bronchiectasis; and such differentiation is of utmost importance therapeutically, as fragility of the respiratory system stands for cautiousness in the surgical approach and simultaneous treatment of both pathologic locations.

The management of the sino-bronchial condition in Kartagener's syndrome is, therefore, a corollary to the preceding considerations. A very notable feature of the relationship between upper and lower respiratory pathology is failure of resolution when there is interference with drainage. The greatest effort should be made to control the condition in both segments because of the mutual contribution toward their maintenance. Chronic sinusitis associated with chronic bronchitis is often completely incurable as long as the bronchiectasis is unrelieved. When the bronchiectasis cannot be adequately treated, bronchial drainage should be aided by posture and other physical treatment. When the bronchiectasis is localized, radical surgical treatment is indicated.

Radical sinus surgery is generally contraindicated in association with bronchiectasis. Naso-antral windows, irrigations

and Proetz displacement technique are quite useful in alleviating the sinus infection. The control of allergic factors and other systemic disorders is in order. Prompt attention must be given to upper respiratory infections to avoid acute exacerbations of the entire respiratory pathology.

The physician, the rhinologist and the chest surgeon should work as a team in discussing the indications for surgical treatment in these patients and the conservative care in the follow-up.

CONCLUSIONS.

In Kartagener's syndrome, bronchiectasis may represent fetal abnormalities, but more often develop and manifest themselves in the postnatal development of the lung with the concurrence of congenital and environmental factors probably related to an allergic constitution.

Sinusitis seems to develop secondarily, but allergic factors may represent an underlying basis in its inception. This is particularly evident in the presence of nasal polyps and hyperplastic nose and sinus pathology.

Ill-development or underdevelopment of the frontal sinuses seems to be related more to the respiratory pathology than to the transposition of viscera.

A constitutional interrelation between upper and lower respiratory pathology dominates the clinical picture of Kartagener's triad and is fundamental in its therapeutic approach.

SUMMARY.

The intimate relationship between upper and lower respiratory tracts is stressed on anatomical, physiological, pathological, clinical and therapeutic bases.

Two cases of Kartagener's syndrome are reported with the sinographic and bronchographic studies.

The pathogenesis of this syndrome, analyzing the relationship between the items of this triad, is discussed.

The clinical and therapeutic aspects of bronchial disease

and pathology of the upper respiratory tract in Kartagener's syndrome are typical expressions of the unity of the respiratory system. Close cooperation between otolaryngologist and chest physician is a must for therapeutic success.

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SIEGLE'S PNEUMATIC EAR SPECULUM MODIFIED FOR A MANOMETER.*

A Preliminary Report on Findings.

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HISTORICAL.

In his textbook on Diseases of the Ear, written in 1902, Politzer[1] emphasizes "that important method of examination with Siegle's speculum, which is indispensable for the diagnosis of middle ear affections . . ." Through the years the speculum has remained indispensable, and its usefulness has increased, yet there never has been made a fundamental alteration for clinical purposes in that speculum.

WHY MODIFY SPECULUM?

Quite recently, in testing the mobility of the eardrums of hard-of-hearing children using the Siegle speculum, I recorded observations using the terms: *1.* Freely mobile; *2.* Slightly mobile: *3.* Moderately mobile; *4.* Immobile. The question then dwelt with the possibility of a correlation between the amount of hearing and the drum that is slightly mobile, or moderately mobile.

It occurred to me that such terms as *slight* and *moderate* should be eliminated, and that the air pressures in the speculum that make the eardrum move, should be measured. The need, it seemed, was to get measurements of eardrum mobility in various normal and abnormal states of the middle ear and Eustachian tube; therefore, the following modification of the Siegle speculum was made (see Fig. 1).

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METHOD AND PROCEDURE.

A hole was drilled into the pneumatic speculum, and into this opening a metal tube about 1 cm. long was welded. Air forced into the speculum can then come out the metal tube and, by means of a rubber tube, can be conducted into a U-shaped mercury or water manometer, or some other type of gauge. Apparently air pressure in the speculum would equally affect the eardrum and the manometer.

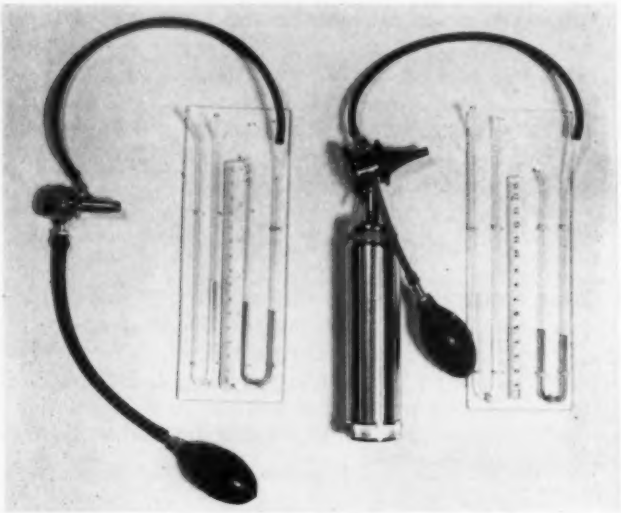

Fig. 1.

The U-shaped manometer is made by bending a glass tube to a rounded "U" and mounting it on a small plastic board, to which is glued a millimeter ruler. Two tubes are so mounted, one to hold mercury, the other water.

With the otoscope thus equipped for measurements and applied to the patient's ear, positive and negative pressures are gradually increased until the umbo (or sometimes a membranous part of the drum) is seen to make its smallest visible movements. While maintaining these movements with pres-

sures as uniform as possible, we see that the column of water is moved up and down the U-tube a total distance of 20 mm. or 25 mm. or sometimes 30 mm. It is then recorded that the umbo moved with static pressure changes of ± 20 mm. to ± 30 mm. water. (Records of total ranges seem more expressive than averages.) To verify observations try pressures up to ± 15 mm. water to make certain the lower pressures do not move the umbo.

PRELIMINARY REPORT.

The principal observations to date are as follows:

1. A normal functioning ear may have a drum that is definitely seen to move with pressures of only 1 or 2 mm. of water. Quite often a posterior segment of the tympanic membrane is seen to move while the umbo remains stationary. It then requires a little more (often 2 or 3 mm. water) pressure to make the umbo move.

2. A person may have normal hearing (not over a 5 db loss for cycles 256 through 8,000) with an ear in which the mobility of the drum is so reduced that the umbo will not move until static pressures of ± 50 to ± 60 mm. mercury are put into the external ear canal. Thus, in answer to the question raised above, there could be no correlation between the threshold of hearing and the mobility of the drum, since normal hearing may also be present with the hard-to-move drum. This is contrary to what is generally expected, as learned from conversations held with different otologists. With one exception, the six or more otologists interviewed said they would expect the ear with the hard-to-move malleus to have impaired hearing.

3. Contrary to what may be expected, the malleus or other parts of the typanic membrane in the ears of some aged individuals are found to move as readily as in the young.

4. Slight congestion of the malleus or other parts of the drum does not seem to hamper its mobility.

5. There seems to be no impairment of mobility after cerumen has been removed. That means ear plugs would not be expected to impair mobility.

6. With acute tubal obstruction, it may take pressures up to ± 60 mm. Hg. to make a small movement of the malleus. After inflation it is gratifying to see the mobility has increased in some cases to 1 mm. or 5 mm. Hg. or less. This correlates with the improved threshold in hearing.

7. Barometric changes change mobility, comparable to acute tubal obstruction. I took a subject with normal ears up a mountain side, and for each 500 or 1000 foot change of elevation, I made observations on the appearance and mobility of the drums. While driving up the mountains the drum was seen to bulge out like an abscess, but retracted when coming down to lower altitudes. This retracted drum was found harder to move than the bulging drum, the umbo of the bulging drum moving with ± 15 mm. to ± 20 mm. Hg., that of the retracted drum requiring ± 25 to ± 35 mm. Hg. pressure. After swallowing, the Eustachian tubes opened, the subject heard better and each eardrum moved with less than 3 mm. Hg.

8. Perhaps of greater interest and practical import are the observations on the following case:

A young man recovering from a cold had severe pain in his right ear during the night. On examination the next afternoon, his right eardrum was red in its entirety. Since the umbo moved with static pressures of only ± 7 to ± 10 mm. water and the posterior quadrant of the drum required pressures of only ± 3 to ± 5 mm. water for visible movements, I decided against a myringotomy at that time. The patient was put to bed in the recovery room, and two hours later the mobility of the drum was again measured. This time the posterior quadrant of the drum was found to be immobile, and the static pressure required to move the umbo had increased threefold. The drum, as yet, was not bulging; however, because of this marked change in mobility it was thought that the middle ear had become partially filled with inflammatory material. A myringotomy, followed by inflation, proved this to be the case.

DISCUSSION.

Sources of Error in Measurements.

It is impossible to keep your eye on the patient's ear and the manometer at the same time. The surge of the mercury, or the water, up and down the U-tube is too rapid for a second party to be of much help. That means that the hand on the air pressure bulb of the otoscope must make uniform pressures, plus and minus, while the eye keeps changing from the eardrum

to the manometer. Strictly uniform pressures are impossible, but the recording of the ranges that cause the first visible movements of the drum seems reliable; however, a big easy-to-see excursion of the drum takes a lot more pressure to produce than a movement that is barely visible, and one must be careful to take the reading at the first definite visible movement.

Why Should an Ear With Evident Reduced Mobility of Its Drum Function Normally?

The answer must lie in the fact that the pressures exerted by the pneumatic otoscope do not simulate those of sound waves. They differ as to (a) pressure, as to (b) amplitude, and (c) frequency.

Pressure variations of ± 60 mm. Hg. are equivalent to ± 56,600 dynes per sq. cm., whereas + 980 to – 980 dynes per sq. cm. is the functional range of sound.[2a]

According to Wever and Lawrence[2b] "The amplitude of aerial movements that are of practical importance cover a very wide range, from $10,^{-9}$ cm. which is barely perceptible under ideal conditions, to $10,^{-2}$ cm. which is approaching a magnitude dangerous to the ear." Now *this amplitude* of vibration, the $10,^{-9}$ cm. is a distance, according to modern physics, that is about one-tenth the diameter of a hydrogen molecule, hence cannot be compared to the eardrum movements made by hand. It is also self-evident that the otoscope cannot move the eardrum with the frequency comparable to audible sound waves having a range of 20 to 20,000 double vibrations per second.

Finally, it is evident that the drum which offers resistance to artificial air pressures in the pneumatic speculum may not necessarily offer resistance to sound waves.

Previous Work on Measuring Eardrum Mobility.

Kobrak[3] did ingenious work on fresh temporal bones measuring linear displacement of umbo from static pressure changes in the outer ear canal in testing eardrum elasticity. Wever and Lawrence[2c] wrote that Dahman, as well as Kobrak, took readings with positive and negative pressures in the ear canal and "obtained greater outward than inward excursions

of the drum membrane and manubrium over the main course of measurements." We were unable to find whether the measurements I have described have ever been made as a part of the routine otologic examination.

Is It of Value to Measure Eardrum Mobility in Ear, Nose, and Throat Practice?

The answer is "Yes," but to properly evaluate the various types of otitis media and associated tubal obstructions we need more data. We hope others who are interested will make contributions in this wide open field.

CONCLUSION.

It is a simple procedure to adapt the Siegle ear speculum to a manometer. Eardrum mobility can then be measured, recorded, and communicated as a function of static pressure changes in the outer ear canal. Such measurements take less than one minute of extra time, they give added information, they stimulate interest in the case, and by drawing attention to data observed they call for more work to understand the observations.

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1. POLITZER, D. ADAM: Textbook of the Diseases of the Ear, p. 76. Lea Brothers & Co., Phila., 1902.

2. WEVER, E. G., and LAWRENCE, M.: Physiological Acoustics, pp. 22, 148, 194. Princeton Univ. Press, Princeton, N. J., 1954.

3. KOBRAK, H. C.: *Jour. Acoust. Soc. Amer.*, 20:2-128, Mar., 1948.

575 Fifth Street.

SIXTH INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY.

The meeting dates of the Sixth International Congress of Otolaryngology are again emphasized as May 5th through May 10th, 1957. The scientific program for the Plenary Sessions is now complete and is as follows:

CHRONIC SUPPURATION OF THE TEMPORAL BONE.

OPENERS: Marcus Diamant, Central County Hospital, Halmstad, Sweden—Anatomical Etiological Factors in Chronic Middle Ear Discharge.

Luzius Rüedi, Zurich, Switzerland—Pathogenesis and Treatment of Cholesteatoma in Chronic Suppuration of the Temporal Bone.

Horst Wullstein, Director, Otolaryngological Clinic, University of Würzburg, Germany—Surgical Repair for Improvement of Hearing in Chronic Otitis Media.

DISCUSSERS: A. Tumarkin, Liverpool, England; Juan Manuel Tato, Buenos Aires, Argentina; T. E. Cawthorne, London, England; Fritz Zöllner, Freiburg, Germany.

COLLAGEN DISORDERS OF THE RESPIRATORY TRACT.

OPENERS: Hans Selye, Director, Institute of Experimental Medicine and Surgery, University of Montreal, Faculty of Medicine, Montreal, Canada.

Introduction:

Michele Arslan, Padua, Italy—The Upper Respiratory Tract.

Leslie Gay, Physician-in-Charge, Allergy Clinic, The Johns Hopkins Hospital, Baltimore, U. S. A.—The Lower Respiratory Tract.

DISCUSSERS: Victor E. Negus, London, England; Branimir Gusic, Zagreb, Yugoslavia; Aubrey G. Rawlins, San Francisco, U. S. A.; Henry L. Williams, Rochester, Minn., U. S. A.

PAPILLOMA OF THE LARYNX.

OPENERS: Jo Ono, Tokyo, Japan—Etiology.

Plinio de Mattos Barretto, Faculty of Medicine, University of Sao Paulo, Brazil.

Diagnosis:

F. C. W. Capps, London, England—Therapy.

DISCUSSERS: C. A. Hamberger, Göteborg, Sweden; Pedro Hernandez Gonzalo, Havana, Cuba; Eelco Huizinga, Groningen, Netherlands; Albert von Riccabona, Vienna, Austria.

Applications to present voluntary papers are being received regularly and anyone wishing to present such a paper should make known his intentions prior to the deadline of Oct. 1, 1956.

The motion picture sessions, as well as the scientific exhibits, will prove to be outstanding in every respect. It is essential that anyone wishing to present an exhibit should make his intentions known immediately, as the final date for consideration is Aug. 1, 1956; applications to present motion picture films should be sent in before Oct. 1, 1956. Anyone planning to attend the Congress and who has not yet registered should do so immediately in order to obtain hotel registration priority.

For more detailed information pertaining to the Sixth International Congress please communicate with the General Secretary, 700 N. Michigan Ave., Chicago 11, Ill., U. S. A.

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non-addicting—
does not cause drowsiness,
nausea,
or constipation

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Syrup, Tablets, Expectorant (w/NH_4Cl)

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